SCIENTIFIC AMERICAN SUPPLEMENT. No. 1137

Scientific American, established 1845.
Scientific American Supplement. Vol. XLIV. No. 1137.

NEW YORK, OCTOBER 16, 1897.

Scientific American Supplement. $5 a year.
Scientific American and Supplement. $7 a year.

PREVENTION OF THE SLIDING FRICTION OF BALL AND ROLLER BEARINGS.

WHEN two parts of a machine displace themselves, one with respect to the other, in a circular motion, their friction develops stresses which are variable and which have the effect of absorbing a very appreciable part of the work developed by the motor. Such, for example, is the case with the pillow blocks supporting a revolving shaft. However carefully the lubricating be done, and whatever be the value of the lubricator employed, such frictions are inevitable; the pieces in contact wear irregularly, and, in the long run, there occur flattenings that still further increase the resistance to be overcome. It is for this reason that bearings are provided with linings of soft metal, bronze or regulus of antimony, which support all the wear and are easily replaced.

General Morin's experiments have permitted the fact to be recognized that under proper conditions of manufacture and lubrication, the coefficient of the sliding friction of a shaft in its bearings is 0·054.

In calling T the work absorbed by friction, P the stress exerted, C the path traversed, and F the coefficient of friction, the value of T is given by the formula:

$$T = P \times C \times F.$$

It will be seen from a simple inspection of this formula that the work absorbed by friction is so much the less in proportion as the coefficient of friction is less. An endeavor has, therefore, naturally been made to find a means of substituting rolling friction, the coefficient of which is much less (0·001, according to Poncelet), for sliding friction. Were such substitution perfectly realized, it will be seen that in this second case the friction would be 54 times less than in the first. But in practice we are far from reaching such a result. In fact, roller bearings and ordinary ball boxes with cells, perforated disks, superposed rings, etc., only partially suppress sliding friction, a notable part of which is simply displaced, as may be easily seen from an inspection of Fig. 1.

Let A be a shaft revolving in the direction shown by the arrow and bearing against a series of rollers, B. Through the motion of the shaft, these latter will revolve in a direction opposite that of the latter and will rub against each other at their points of contact, a, since at such points each will revolve in a direction opposite that of the other.

As may be seen, the addition of the rollers has no other result than that of transferring to the points, a,

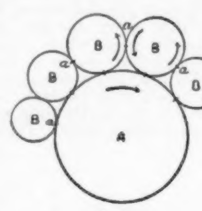


Fig. 1

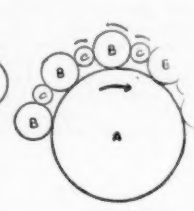


Fig. 2

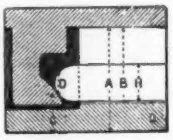


Fig. 3

the sliding friction that was developed previously upon the circumference of the shaft, in diminishing it, it is true, but without suppressing it. In fact, calculation shows that by the substitution of ball or roller bearings for smooth ones, the saving in the work of friction reaches, at a maximum, 40 per cent. And yet this figure diminishes rapidly as a consequence of the wear that is inevitable, even with the use of pieces of steel, tempered and trued after tempering.

In order to obviate the sliding friction of rollers, B, M. G. Philippe has conceived the ingenious idea of isolating the rollers from each other by means of intermediate and smaller ones, C, which revolve in a direction contrary to that of the first, that is to say, in the same direction as the shaft, A.

A simple inspection of Fig. 2 will show that there is a rolling friction at the points of contact of the rollers, B and C, as well as between the rollers, B, and the shaft, A.

We have here supposed a case of rollers, but it is evident that the results will be the same when balls are employed. The sole condition to be realized is to select the diameters of the large and small balls in such a way that the paths traversed shall be equally proportional.

Fig. 3 supposes a case in which the axis, O, in revolving, carries along the large balls, B, which roll in the compartment, A, and communicate their circumferential velocity to the small intermediate balls, H. The latter are kept in place by means of a path, C, upon which they rest by their extremity, D, and which is cast in a piece with the chamber, A. In order that the paths traversed shall be equally proportional, the diameters of the elements must satisfy the following equation:

$$\frac{B}{A} = \frac{C \times H}{B \times D}$$

C and D are here the diameters of contact.

M. Philippe has studied various arrangements that permit of the application of his system to the most ordinary uses of mechanics. Figs. 4 and 5 give two arrangements of roller cages that may be applied almost without change to the present pillow blocks. In the fifth, the path, C, is connected with the bearing, A, while in the fourth it is connected with the shaft, O.

Fig. 6 gives the arrangement of a bicycle hub with ball bearings, the regulation of which is effected, as usual, by tightening the cone. The hub for light vehicles (Fig. 7) is, as may be seen, analogous to the preceding. These hubs for light vehicles will prove useful in automobile carriages, where, more than anywhere else, the necessity has made itself felt of suppressing friction in order that the motor may suffer no loss of power. When there are heavy loads to be supported, rollers rather than balls should be employed.

American electric tramway companies frequently

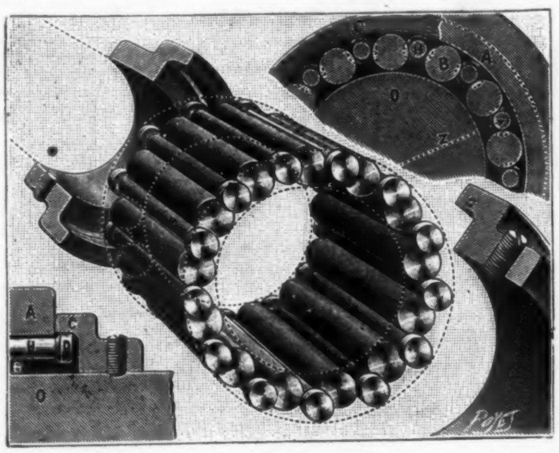


FIG. 4.—MOVABLE ROLLER CAGE WITH PATH CONNECTED WITH THE SHAFT, O.

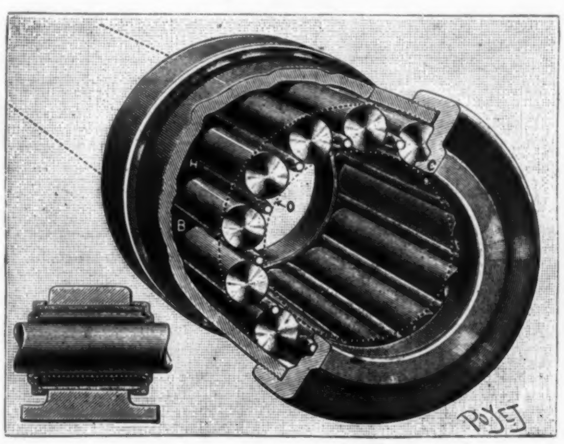


FIG. 5.—MOVABLE ROLLER CAGE WITH PATH CONNECTED WITH THE BEARING, C.

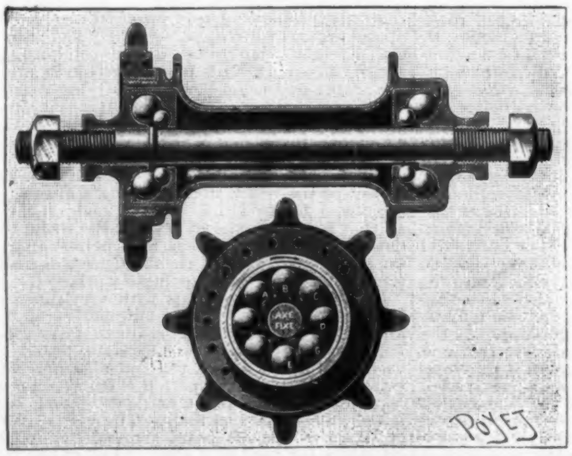


FIG. 6.—BICYCLE HUB WITH BALL BEARINGS.

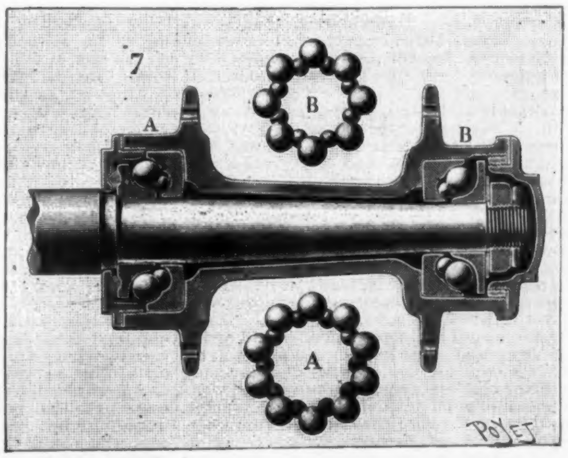


FIG. 7.—HUB OF A LIGHT CARRIAGE WITH BALL BEARINGS

make use of roller bearings, but in employing the different ordinary systems of which the capital defect has been shown above.—La Nature.

A PORTABLE RECORDER FOR TESTS OF METALS.*

By Mr. G. C. HENNING, New York.

WHEN it is desired to know all about the working of a steam engine, to study the working of the steam valves, piston, clearances, etc., the indicator is used; this gives a record on rectangular co-ordinates of travel of the piston, and to the steam pressures throughout the complete cycle. Similarly, if it were possible to design an instrument like the indicator in its accuracy, portability, and universality, to record the behavior of materials from beginning to the end of the test, it ought to be of general utility for it, and its introduction ought to be comparatively easy. It should be complete in itself, readily and quickly applicable to all testing machines, and should be so constructed as to be readily examined for accuracy, and should, of course, be durable.

A great many recording instruments for stress-strain diagrams have been designed and used from time to time, but all have been found wanting in one or more respects, and not one has been made portable, so that engineers could take it from works to works and use it without first being compelled to make more or less costly mechanical preparation for its use in each case. Moreover, the instruments in almost every case are so costly that their general introduction and use became impossible, especially in view of their limited utility. Some of them, otherwise very ingenious, gave diagrams on circular co-ordinates which made them practically useless. Among apparatus used for this purpose may be mentioned those of Wicksteed, Unwin, Kennedy, Barr, Gray, Martens, Olsen, Mohr and Federhaff, and of Grafenstaden, but as they are fairly well known, it is not necessary to describe them in this paper. My conception of a practical recorder for testing materials is as follows:

It must be portable and compact, requiring no extra precautions in adjustment or regulation, and without having the accuracy of an instrument of precision, must be perfectly trustworthy, and as correct as the other apparatus in connection with which it is used. It must cover a wide range of work, of short and long, large and small test pieces, such as are found in general use, and must be applicable to hard and soft materials as well. The apparatus should be applicable in a horizontal as well as in a vertical position. Moreover, it should give a complete record from beginning to end of the test, showing the more important elements on an enlarged, and the lesser on a natural scale. Thus, while elongations within the elastic limit—yield point—are very minute, and must be recorded on a magnified scale which is trustworthy, changes of length beyond this critical point are very large, rapid, and variable; hence measurement with a steel scale suffices, and the record on a diagram may be on actual scale. This change of scale must, however, be positive, controllable, and at a fixed instant or point, and must not introduce errors in the record. In case of materials of slight extensibility, however, the entire record should be on one scale from beginning to end, and the instrument should be so attached that it does not nick or injure the material so as to affect its point of rupture or strength.

As materials under test change shape rapidly and constantly, the instrument must be so designed that this variation does not introduce errors by slipping or tilting or otherwise. Means must be readily applicable which will check the accuracy of the instrument at all times. As materials are generally tested at the present time, there is no lasting record of the qualities that are claimed to have been found. Moreover, it is well known that many properties of materials cannot be determined except by an autographic stress-strain diagram. The curves obtained vary according to the treatment which the material has been subjected to, and annealing or straining produces such marked results that an autographic record would at once indicate how the material has been treated. Hardening, cold rolling, tempering, and other processes are made apparent by the characteristic features of the curves. With the use of such a recorder, it would become instantly apparent whether material had been previously intentionally strained to raise the elastic limit, as is well known to have been done. Overheating of material would be clearly indicated by the change in the curve, and the general uniformity of any lot of material could be readily determined.

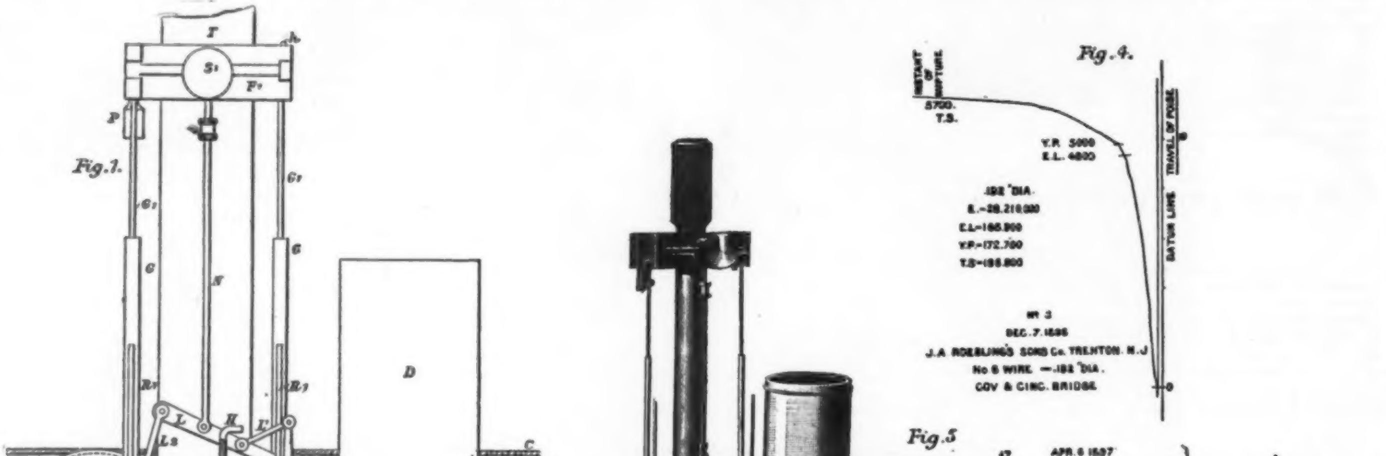
The instrument should also be applicable for compression tests, so as to record the behavior of material when subjected to compressive stresses. The engraving shows my design of such portable recorder, as based on the conception as explained. Two hinged frames, F and F_1, are provided with knife-edge pointed screw, S, passing through bushes, b, which carry springs, E. Hinge-pins, h, allow the frames to open, while taper plugs, p, secure them rigidly together when closed around the test piece, T. In order that the knife edges, K, in the upper and lower frames, bear on the test piece, T, at given known distances, the guide rods, g_1, sliding in tubes, g, are made of a certain length. These rods, g_1, and tubes, g, cause the frames, F and F_1, to recede from or approach each other without changing their parallelism, and prevent any possibility of rocking of the lower frame, F, which carries the drum, D, on the arm, A. The drum, D, must remain at a uniform distance from the axis of the test piece throughout the test, as any change therein would vitiate the record materially, either increasing or reducing the apparent length of string, C.

The lower frame, F, also carries a parallel motion, G L, as in ordinary use in steam engine indicators. This parallel motion is actuated by the upper frame, F_1, through the connecting rod, N, which is interchangeable for longer or shorter pieces. The lever, L, of this mechanism carries a pencil or pen at m, which draws a line upon the paper wrapped on D, either horizontal when the drum is revolved, or a straight vertical line when the drum is stationary, and the frames, F and F_1, approach or recede from each other. If the drum revolve while the lever, L m, moves, any curve may be obtained according to their relative motions. As the possible change of length of material during test and up to the instant of rupture is very great, a very long drum would be required to record it on a magnified scale up to that point; the parallel multiplying motion would also become very large and cumbersome. Moreover, the change of length within the yield point is minute, and cannot be recorded to any purpose except on a magnified scale. Now, therefore, to record the elastic changes of length on a magnified scale, and the permanent changes on a natural scale, as the latter are never measured closer than to the nearest $\frac{1}{100}$ inch, I employ the following devices: The stop, H, arrests the multiplying mechanism at any desired point, after which it moves as a unit, and any further change of length is recorded on natural scale. To act as described, the parallel motion mounted on the bar, G, has two tubes, R, sliding on rods, R_1, the latter only being fastened to the frame, F. These tubes, R, are split, and can be made to grip the rods, R_1, with any necessary pressure.

It will be seen that the total maximum resistance to motion between frames, F and F_1, is the friction of tubes, g and R, on rods, g_1 and R_1, and friction of pen, m. As long as the motion is recorded on a magnified scale this resistance will be only the friction of rods, g_1, in tubes, g, of pen, m, and the resistance of the parallel motion. Therefore the total resistance will be minute, and not likely to affect the record in even the slightest manner by slipping of the knife edges and frames. The paper on the drum must move past the pen, m, at a rate equal or proportional to the motion of the poise weight on the beam. As loads are large or small according to size and quality of test piece, the poise must travel more or less to balance it. As it is desirable, however, to record all tests on the same sized diagram, the travel of the poise weight is reduced or increased by a grooved pulley, P, round any groove of which the string, C, tied to poise weight, is wrapped; the free end of this string carries a small weight to keep it always at the same tension. On any other groove of the pulley, P, another string passing around the drum, D, is wrapped, which is kept at the same tension by a small weight at its free end. By a proper selection of position of the two strings on the various grooves of the pulley, any desired rotation of the drum may be obtained.

Application of Instrument.—A light pulley is secured to the frame of the testing machine, over which the string, C, passes, the other end being attached to the poise weight, or to any mechanism moving in synchronism with it. A sheet of paper being mounted on the drum, the frames, F and F_1, are opened after the screws, S, have been so adjusted that the distances between the knife edges, K and K_1, are about ⅝ inch less than the thickness of test piece. Then the frames are placed around the test piece, which has been placed in the machine, the frames are closed, pins, p, are inserted, the string, C_1, is passed around D, and C round the proper groove on P, while the poise weight is at 0—zero—and the test may begin. If it is desired to draw a base line for measurements of elongation, the drum is given one revolution while the pen bears against the paper; it is not necessary—though it can readily be done—to draw the other axis to the base line, as the motion of the pen is always at right angles to it. If it is desired to mark the scale of loads on the base line, all that is necessary is to revolve the drum by running out the poise to the several load points, and then making a mark for each of them. Once this scale is determined, it will be the same in all work.

In the case of materials with very slight change of length, during the test the automatic stop is not used, and curves like those on diagrams 1 and 2 are obtained. When ordinary structural material is tested, the stop is used, and a curve like that on diagram No. 3 is obtained; in this the elongation is drawn on a multiplied scale from 0 to the point marked "Stop;" beyond this it is drawn to natural scale. The very decided change of direction at the point marked "Stop" cannot be mistaken for anything else. As all of the instruments hereafter made will have a multiplication of ten times, this point of change of scale will be even more clearly defined than on the card shown. An investigation of the effect of stretch of the string or wire has demonstrated that it is negligible, and the divisions marked on diagram 2 will prove this. That it should be so will be clear when it is remembered that the drum revolves with a constant resistance, and that the string itself is always under constant tension, due to the small coun-



HENNING POCKET RECORDER.

* Iron and Steel Institute.

terweight tied to the string, C. It will be noted that at the instant of rupture the apparatus can separate into two independent parts, and that the knife edges permit a certain amount of slip; the combined effect of these two facts obviates any injury to the instrument at the instant of rupture, provided the accidental flying about of the gripping wedges is prevented by blocking them, which is always done by a careful person. Experience has shown that the instrument can be used rapidly without interfering to any degree with the work of the laboratory, and that the results are perfectly trustworthy.

[Continued from SUPPLEMENT, No. 1136, page 18156.]

PERPETUAL MOTION.—VI.*

FIG. 26 is an attempt to secure a perpetual motion by the application of electricity. It is the invention of a citizen of Kansas. In his communication inclosing the drawing, he says:

"You will observe friction (the old enemy) is an ally in this. If a magnet of a certain power will not move the electric plate, the power could be increased without perceptible loss of tension, by decreasing the resistance which the magnet and conductor offer."

In the engraving, A represents a frictional electrical machine; B, a crank; C, an electro magnet; D, wire conductors; F, a trunnion; G, an armature; E, a circuit closer; H, a pitman; I, an insulating substance; and J, spiral spring.

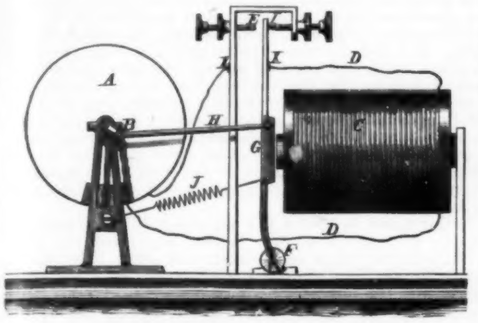


FIG. 26.

The device is expected to operate as follows:

The frictional electrical machine is started, which magnetizes the temporary magnet and draws the armature toward it. This breaks the circuit at the point, I, E, which demagnetizes the temporary magnet and allows the spring, J, to again close the circuit. By this means a continued motion is expected to be kept up.

To those not familiar with the science of molecular physics, this device may appear very plausible; a little reading, however, upon the subject of the correlation of forces will serve to show its utter fallacy.

Fig. 27 is the invention of Jean Clunet, of Lyons, France, patented in England, 1869, under the name of "A New and Improved Motive Power." It is thus described:

The invention relates to a new and improved motive power operating without noise and without expense. It consists in giving a rotary motion to a wheel, which is destined to transfer, by the ordinary means, the power obtained by the employment of any even, smooth blocks of stone, petrified mortar, iron, cast or wrought, or other heavy materials, in the form of cubes preferred, and of which the number and volume are governed by the amount of power desired, and causing them to descend in the ordinary atmospheric air, but to ascend in a liquid whose density is equal to their density, by which means their weight is annulled. For this purpose these blocks, when descending, are hung to hooks fixed to an endless chain turning upon the wheel receiving the motive power, which is of the shape of a hexagon, and placed on the top of a suitable framework, and upon another wheel of the shape of a square, which is placed at the bottom of said framework, and partially in a receptacle or tank of water, or any other liquid. When these blocks have arrived at the lower portion of their course, they detach themselves from the hooks on which hitherto they hung attached to the chain, which latter continues its ascending and rotary motion, and the said blocks descend and reascend within the tank, confined to their place and guided by an endless band and conducting wires stretched from supports for that purpose fixed on the top and bottom of the framework. They now, being thus guided, and following one upon another, find their way into another species of tank, placed vertically, likewise filled with a liquid similar to that in the first mentioned tank, and when arrived at the top of this second tank they tilt and slide along upon a horizontal shelf of rollers until they reach the hexagon-shaped wheel and the endless chain, when they recommence their descent. In order prevent the liquid from running or descending from the second tank into the first, the blocks enter from one tank to the other between rollers and grooved pulleys pressed against the blocks by springs so as to shut off all way to the water. The detaching of the blocks from the endless chain takes place of itself, so to speak, from the position they find themselves in, in consequence of the rotary movement and of the turning over of the said chain upon the lower wheel in the shape of a square. The endless band receives a continuous descending and rising motion from the weight of the blocks, which give every motion that the apparatus possesses, and which motion would be perpetual, if, upon the axle of the hexagon-shaped wheel transmitting the force obtained to the machinery by means of a driving pulley keyed to one of its ends, there were not keyed to the other end a brake wheel with a hand crank, by means of which the movement may be stopped or modified. Instead of two receptacles, it would perhaps often be better to have but one, the rollers and grooved pulleys already alluded to being placed at the entrance of the single tank instead of the second, the blocks acting in the same manner.

* Reprinted from the SCIENTIFIC AMERICAN, 1870-71.

The engraving is a side section, in elevation, of the whole apparatus.

A represents the blocks; B is the hexagon-shaped wheel; C is the endless chain, which remains attached to the said wheel by means of its pointed hooks, which successively enter similar recesses made in the circumference of the wheel, the other end of said hooks being square, serving to keep the blocks in their place while descending in conjunction with the conducting wires, D, placed two in front and two behind each block, and one at each side; E is the receptacle; F is the square wheel from which the chain, C, at the bottom of its course is detached to reascend round the wheel, B; G, rollers, of which there are four, made of India rubber or other elastic material, placed at the entrance of the receptacle, E; and H is the India rubber or other suitable angle pieces, also placed at the entrance, between which rollers, G, and angle pieces, H, pass with slight friction the said blocks, after being disengaged from the chain, C. These blocks, A, angle pieces, H, and rollers, G, being in close contact, form a permanent stoppage, so that the water cannot issue, and said blocks, when in the receptacle, are placed in the middle of the same, where they are kept in equilibrium by the water, and are pushed and moved forward by the blocks which descend after them. I is the endless band, resting on supports, J, fixed to the inside of the receptacle, supporting the blocks and moving with them. The blocks, when in the vertical part of the receptacle, are conducted by four wires, one on each of their four sides. K is a roller upon which tilt the blocks, guided by the endless band when on the top of the receptacle to leave the same; L, friction rollers, on which fall and roll the blocks after having tilted, in order to reach the hexagon wheel, B; M M are the two pulleys on each side of the hexagon-shaped wheel, for applying the brake and for transmitting the power obtained to other machinery. The equality in the density of the liquid and the blocks is obtained by hollowing the blocks so that they may easily rise to the top of the receptacle when therein. The desired result is obtained by the use of any other liquid, the volume of the blocks being proportionate to their density; also the weight of the blocks may be more or less than that of the liquid, but equality in weight is preferable.

No less a person than Sir William Congreve, M.P. and inventor of the famous Congreve rocket, figured in his time as a believer in, disputant upon and inventor of a perpetual motion. So sure was he that he had discovered the long-sought principle upon which self-moving machines could be constructed, that he patented his device, although we believe he never claimed to have succeeded in getting it to work. Nevertheless, he obstinately maintained that it would work, in spite of the mathematical demonstrations of the absurdity of his views made by several eminent mathematicians.

Fig. 28 shows this device. As will be seen, it is based on a principle hitherto not mentioned in this series of articles, viz., the power of capillary attraction.

Three horizontal rollers are fixed in a frame; an endless band of sponge runs round these rollers, and carries on the outside an endless chain of weights, surrounding the band of sponge, and attached to it, so that they must move together; every part of this band and chain being so accurately uniform in weight that the perpendicular side will, in all positions of the band and chain, be in equilibrium with the hypotenuse, on the principle of the inclined plane. Now, if the frame in which these rollers are fixed be placed in a cistern of water, having its lower part immersed therein, so that the water's edge cuts the upper part

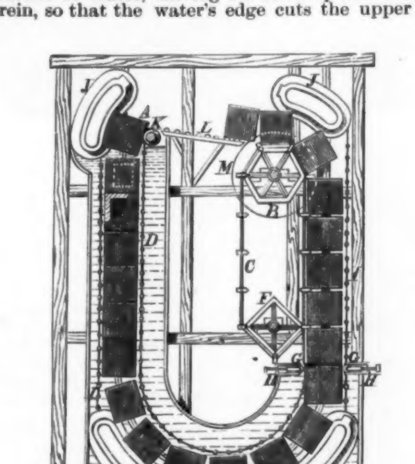


FIG. 27.

of the rollers, then, if the weight and quantity of the endless chain be duly proportioned to the thickness and breadth of the band of sponge, the band and chain will, on the water in the cistern being brought to the proper level, begin to move round the rollers in the direction of the arrow, by the force of capillary attraction, and will continue so to move.

On the perpendicular side of the triangle, the weights hanging perpendicularly alongside the band of sponge, the band is not compressed by them; and its pores being left open, the water, at the point where the band meets its surface, will rise to a certain height above its level, and thereby create a load, which load will not exist on the ascending side, because on this side the chain of weights compresses the band at the water's edge, and squeezes out any water that may have previously accumulated in it; so that the band rises in a dry state, the weight of the chain having been so proportioned to the breadth and thickness of the band as to be sufficient to produce this effect. The load, therefore, on the descending side, not being opposed by any similar load on the ascending side, and "the equilibrium of the other parts not being disturbed by the alternate expansion and compression of the sponge," the band will begin to move in the direction; and as it moves downward the accumulation of water will continue to rise, and thereby carry on a constant motion, provided the load be sufficient to overcome the friction on the rollers.

Now, to ascertain the quantity of this load in any particular machine, it must be stated that it is found by experiment that the water will rise in a fine sponge about an inch above its level; if, therefore, the band and sponge be one foot thick and six feet broad, the area of its horizontal section in contact with the water would be 864 square inches, and the weight of the accumulation of water raised by the capillary attraction being one inch rise upon 864 square inches, would be 30 lb., which, it is conceived, would be much more than equivalent to the friction of the rollers.

Now, the fallacy in this plausible argument is found in the words quoted. The equilibrium of the parts of the chain is disturbed at the moment the chain moves downward to compress the ascending file of sponges, and just enough disturbed to counterbalance the increase of weight on the perpendicular side. It is

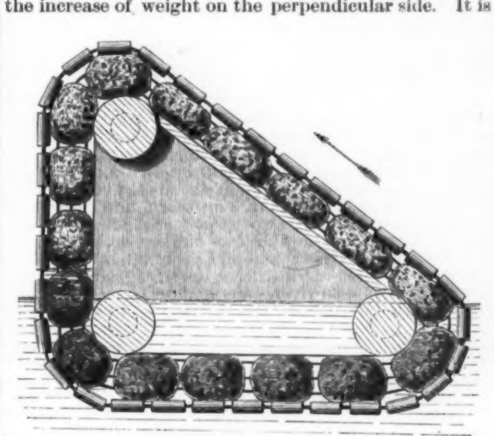


FIG. 28.

somewhat astonishing that a man of Sir William Congreve's ability should not have seen this at once, and still more astonishing that he should have disputed it when pointed out to him, which he did vehemently. Writing upon this subject, he says:

"For my own part, not being able to see any reason why the machine should not act, I confess that my faith is sufficiently strong to have induced me to take out a patent, and I am determined to use my best exertions to give mankind the benefit of this discovery, should it turn out, as I sincerely believe it will, a source of perpetual power without expense."

(To be continued.)

RAILWAY BUILDING IN THE NUBIAN DESERT.

A CORRESPONDENT of the London Times, writing from Wady Halfa on August 26, says that the railway between Wady Halfa and Abu Hamed, now in course of construction, is, from several points of view, one of the most interesting military lines in the world. For one thing, it crosses a portion of the Nubian desert which has apparently never before been trodden by the feet of man. In one place, however, it runs across what seems to have been the route taken a long time ago by a large body of men; for here, 60 miles from the nearest water, the engineers came across a mysterious collection of many hundreds of broken zeers, or earthen water coolers; they were two-handled, graceful amphoræ of a shape unknown in modern Egypt. This discovery naturally started a good deal of conjecture. Some remembered that Cambyses sent an army across this desert; then, to come down to more modern times, Ismail Pasha once dispatched a force of 2,000 men to Abu Hamed, which entirely disappeared in the desert and was never heard of again. Said Pasha, too, traveled in luxurious state to Abu Hamed in a carriage drawn by eight camels, with an army watering the desert in front of him to keep down the dust. The Cambyses theory as to the origin of these zeers is at present the most favored, as carrying us back to a respectable antiquity. There is yet another and a not unlikely explanation. There are numerous traces of ancient gold diggings in this desert. Do these broken vessels mark the spot where these diggers of old, of whom the Arabs have preserved no traditions, had one of their mining camps?

Describing a trip to the end of the line, the writer continues: When darkness fell we were well out in the desert, and, therefore, in a far more pleasant climate than that of the Nile bank, with its damp heat. Here the air was dry, pure and deliciously cool; it became even cold before dawn; one often needs three blankets to cover one at night at the summit of the line; here, too, we escaped for a time the ever irritating Egyptian flies. Even the air of midocean is not more sweet and invigorating than that of the wind swept, open desert, where, say the Arabs, the only diseases are hunger and thirst. So healthy, indeed, is it here that out of the 2,000 men working hard day after day in the sun on the railway construction there are rarely more than 12 on the sick list; and accidents account for the majority of these cases. It is noticed, by the way, that the men put on this work, receiving as they do regular and wholesome rations, rapidly improve in physique, increasing in size and weight to a remarkable extent. They all, both yellow Egyptians and coal-black Soudanese, appeared to be in the best of spirits. These people have a great capacity for railway construction, and seem to thoroughly enjoy their work.

Of the cheery, ever-grinning Soudanese, numbers were dervishes but a few months since fighting against us; and some were still wearing the jibbehs or Mahdist uniforms from which the colored patches had been torn off. One black ex-dervish worthy of mention is Somid, the Soudanese jester of the camp, who can al-

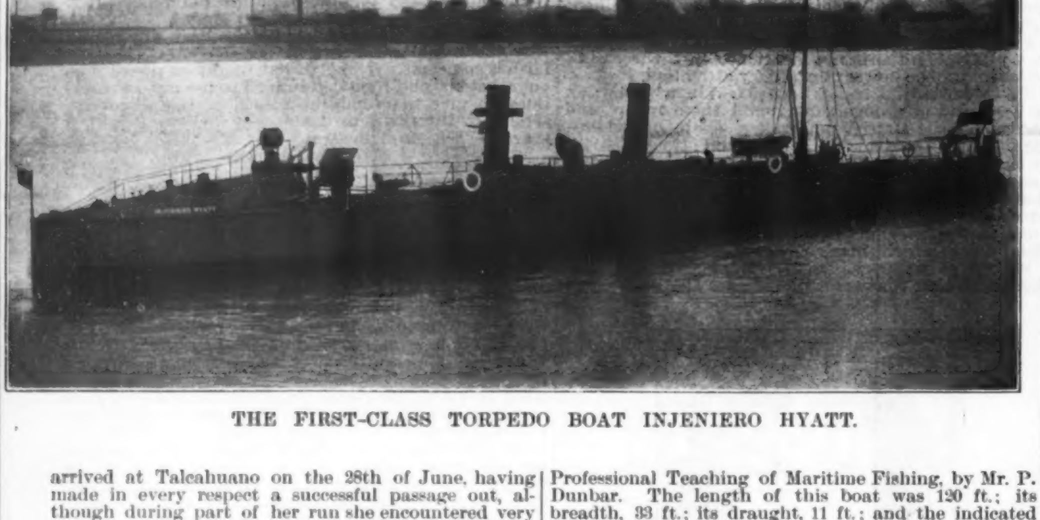
ways raise a roar of laughter in the working gangs, and is of distinct service, keeping up the men's spirits as he does by his clever mimicry and queer tricks. A bugler in Hicks Pasha's ill-fated army, he was captured by the dervishes and taken to the Mahdi's camp at Omdurman. There he discovered that he could make his life easier by playing the buffoon, and he became the jester of Wad el Bishara, the famous emir who commanded the dervish forces that were opposed to us last year. He used to be called up to amuse his master's friends by giving imitations of the British officers with whom he had been brought into contact. Recaptured by us last year at the battle of Hafir, he now, when not employed in rail laying, keeps the camp in a roar by his close imitations of his former master Bishara and other dervish notables.

Another correspondent, writing from Debbeh, says that all along the river posts civil tribunals have been established. There is a great demand among the natives for English stuffs and hardware, but at present the whole retail commerce is in the hands of Greeks. Last winter small quantities of gum and ostrich feathers were brought from Dar Fur, and it appears that a great amount of such goods is stored ready for sale as soon as the routes are open for trade.

THE FIRST-CLASS TORPEDO BOAT INJENIERO HYATT.

Messrs. Yarrow & Company, of Poplar, London, have sent us the following particulars of the first-class torpedo boat Injeniero Hyatt, which was one of six seagoing first-class torpedo boats lately built for the Chilean government by that firm. These vessels are 152 ft. 6 in. in length by 15 ft. 3 in. beam, and carry an armament consisting of two torpedo tubes and three quick-firing guns. They have a bunker capacity sufficient to hold 40 tons of coal and their radius of action is about 2,500 knots at a 10 knot speed. Two of these six vessels have been riveted up and tried successfully on the measured mile at the estuary of the Thames (full particulars of the trial annexed). The remaining four boats are being shipped in pieces with a view to being put together and riveted up in Chile. The Injeniero Hyatt left Plymouth on the 28th of April and arrived at Talcahuano on the 28th of June, having made in every respect a successful passage out, although during part of her run she encountered very bad weather. On arrival she went through an official trial with success, and on the examination of the boilers and the machinery everything was found in perfect order and quite satisfactory to the Chilean authorities.

These first-class torpedo boats were provided with two of Yarrow's patent straight tube water tube boilers, of about 1,000 horse power each, and weighing, including water and fittings, 9 tons each. It may here be remarked that lengthened experience has shown that this type of water tube boiler has an economy of at least 10 per cent. greater than the locomotive boilers of equal power which were formerly used in vessels of this class, and owing to the complete absence of leaky tubes through bad stoking, it has been found that less skill is required in the management of this type of water tube boiler than was necessary with locomotive or return tube boilers, because if, through bad stoking, cold air gain access into the furnace, it does not produce any injurious result.



THE FIRST-CLASS TORPEDO BOAT INJENIERO HYATT.

OFFICIAL TRIAL OF THE SEAGOING TORPEDO BOAT INJENIERO HYATT—FEBRUARY 15, 1897.

Draught of water, 4 ft. 1⅛ in. aft, 2 ft. 7⅛ in. forward; mean draught, 3 ft. 4⅛ in. Load on trial, 27 tons. Propeller, 7 ft. 6 in. diameter.

During the three hours' full speed trial in the estuary of the Thames the following runs were made over the measured sea mile on the Maplins:

Number.	Steam Pressure.	First Receiver.	Second Receiver.	Vacuum.	Air Pressure.	Revolutions per Minute.	Time.	Speed in Knots.	First Mean in Knots.	Second Mean in Knots.		Slip.
1	175 lb.	77 lb.	12 lb.	24 in.	1¼ in.	344	2′ 31″	23·841	25·983	26·187		4%
2	180 "	77 "	12 "	24 "	1¼ "	345	2′ 8″	28·125	26·391			
3	185 "	80 "	14 "	24 "	1½ "	350	2′ 26″	24·657				
4	190 "	84 "	14⅛ "	24 "	1 "	365	2′ 5″	28·800	27·257	27·232	27·219	5%
5	190 "	84 "	14⅛ "	24 "	1¼ "	360	2′ 20″	25·714	27·207	27·207		
6	190 "	84 "	14½ "	24 "	1¼ "	363	2′ 5⅛″	28·700	27·207			
7	200 "	86 "	15 "	24 "	1½ "	363	2′ 20″	25·714				

Mean revolutions per minute during three hours, 355·4, equal to 26·8 average speed in knots.

After the three hours' speed trial, circles were turned to starboard and to port in a space equal to about three times the length of the vessel. No trouble was experienced with either engines or boilers.

STEAM POWER IN THE FISHING BUSINESS IN EUROPE.

By Charles Theodore Mason.

The use of steam in the fishing business, says Mr. Georges Roche, in an exhaustive article on the subject in a Paris magazine, permits the regulating of the work at sea, while, at the same time, it assures the product of this work being delivered on land in good condition and in the shortest space of time possible. It also gives more security in the navigation, often difficult, of the fishing boats, and lessens the fatigue of the crew, so far as the handling of the tackle is concerned.

Steam is employed on board these boats either for the propulsion of the boats themselves and the handling of the tackle, the handling of the tackle alone, or for taking the product of the work to land. Steam fishing boats are utilized for the capture of fish with deep sea lines, with drag nets, or, as in the case of herrings and mackerels, with floating nets. Compactly built, more with a view to remaining at sea in all weathers than to furnishing them with a speed that they hardly need, these boats generally remain away from land for several days, in some cases even weeks, fishing in company and relieving each other in the task of taking the fish they have all caught to land. Many small tugs or coasters, and even yachts have been transformed into fishing boats, but at present steamboats are expressly built for the purpose.

The characteristics of a good type of steam trawler were given, in 1889, in the Revue Technique de l'Exposition Internationale. The boats referred to were built by an amateur of Dieppe and were intended only for work in the English Channel, but boats of this class must vary in form and construction according to the marine regions in which they are called to fish. The characteristics are as follows: Length between perpendiculars, 70 ft.; breadth, 18 ft.; depth, 8 ft.; draught, 6 ft., and the horse power 100. The speed of such boats was set down at nine knots an hour.

The characteristics of a Scotch steam trawler were given in a Bulletin of the Society for the Technical and Professional Teaching of Maritime Fishing, by Mr. P. Dunbar. The length of this boat was 120 ft.; its breadth, 33 ft.; its draught, 11 ft.; and the indicated power of its machinery, 500 horse power. The commoner type of these fishing boats doing a similar work is, however, only 109 ft. in length, with an indicated horse power of 300. The net cost of a steam trawler is from $16,000 to $19,000, but smaller ones may be had for $13,000. A sailing trawler furnished with a steam apparatus for hauling in the seine can be bought at Boulogne for about $5,000, but the herring and mackerel smacks, being of a greater tonnage, cost from $5,300 to $7,500.

In France, the ports equipped with steam fishing boats are fairly numerous. Of these, Boulogne supplies 3 large trawlers and 22 smaller ones; Dieppe, 75 of the first and 11 of the latter. Boulogne has also 200 sailing boats equipped with steam haulers, and Fécamp some 40 or more. Some of these last practice trawling in the Channel and in the North Sea, but the majority are engaged in mackerel catching in the Irish Sea, and, during the season for it, herring catching in the North Sea. Some years ago, fishing with steam was started at Trouville, but failed dismally, not, however, on account of any insufficiency in the production of the finny tribe. Between Fécamp and Arcachon there is at present only one boat equipped with steam haulers. Arcachon supplies 8 such boats (five of which belong to the Société des Pêcheries de l'Océan), while S. Jean de Luz supplies 3.

On the coasts of Great Britain there are more than 300 steamboats built of iron, 52 of steel, and 60 of wood, engaged in trawling in the North Sea alone. Some of these are provided with vivaries for carrying the fish alive to land. This large number is still increasing, but on the east coast only, for the boats of this class hardly amount to more than 20 on the west coast. In addition to these steamboats, the English fisheries employ a considerable number of sailing vessels equipped with steam apparatuses for taking in the seine, these vessels being kept in communication with the neighboring ports by means of steamboats, plying constantly to and fro from the fleet. These boats work in company, and in the vicinity of the North Sea banks. As soon as the fish are captured they are put, with small lumps of ice, in boxes specially constructed for the purpose, and in such a manner as to be easily handled. The steamboats, above alluded to, collect these boxes, after delivering whatever provisions, etc., they may have brought with them for the fleet. . . . The boats that work in company engage to remain at sea for two, three, and four months at a time. At Yarmouth, 700 of these sailing craft are employed, summer and winter, in this kind of industry; at Hull, 300 sailing vessels fish in company, and at Grimsby a like number are employed. It was Messrs. Hewett & Company, of London, who, in equipping a large fleet of trawlers, organized the first system of rapid transportation of fish to the various markets along the coast. The boats were then large sailing vessels; but, in 1864, the firm decided to equip steamboats for the purpose. It was not until 1880 that the adoption of these steamboats took place at Hull. The chief ports of Great Britain equipped with these steam craft are Aberdeen, Granton, Leith, North Shields, Sunderland, Hull and Grimsby.

In Germany, in 1884, a fish merchant of Geestemunde on the embrasure of the Weser, equipped the first steamboats for deep sea fishing. In 1889, 25 of these boats were employed on the west banks of the North Sea and in the neighborhood of Norway. To-day this number has increased to 100, working between Hamburg, Geestemunde, Bremen, Emsden, and Lubeck. Some of these are occupied in catching herrings with nets, others with lines, and the rest with trawling nets. In Germany deep sea fishing is an object of solicitude on the part of the government as well as of private societies. Hence it is that in the comparatively short space of 15 years a very important industry has been built up by Germany in the North Sea. In some of the markets where the French have been in the habit of selling a large quantity of salted fish the German fisheries have established a connection that threatens to drive the former out of the business, so far, at least, as these markets are concerned. Holland and Scotland have also begun to feel the effects of German competition.

The Emperor has founded a prize intended as a recompense to the designer and builder of the best model steam fishing boat, and a second prize is to be given to the person who designs the best sailing boat provided with mechanical haulers. Both designs must be studied with a view to economy and simplicity.

In Holland the number of steamboats engaged in deep sea fishing is considerable, and mention must not be forgotten of the ostreiculture of East Escaut, which employs steamboats for the exploitation of the territory conceded it. Moreover, in the lower part of the Rhine and the Meuse, the seines are worked by means of steam apparatus, with the view to capturing the salmon which abound in these rivers, and of which some 60,000 are annually taken.

In Spain of late years a flourishing enterprise in the fishing industry has been established. At Vigo some 40 steamboats are engaged on the rocky banks which skirt the coast in this direction; while some 20 of a larger build, and worked by steam, practice trawling in the Bay of Biscay, coming sometimes as far north as the mouth of the Gironde.

To be successfully practiced, steam fishing requires a considerable outlay of capital. Hence, in England it is practiced only by large companies; while in France, Spain and Germany amateurs or private fishermen mainly interest themselves in it. Nevertheless, in certain ports, as at Groix, in France, the sailing trawlers are owned by a company of fishermen. Not long since, in the west of France, where steam fishing has only been known for some twenty years, a trawler from the Gulf of Gascogne returned, after an absence of twelve days, with a cargo that was sold for 4,000 francs ($800). A Grimsby fishing boat has also brought back to land, as the result of fourteen days' fishing, a cargo worth 545 pounds sterling ($2,725), while, in 1894, a steam trawler from Geestemunde made a haul, during Easter week, that was sold for 14,000 francs ($2,925).

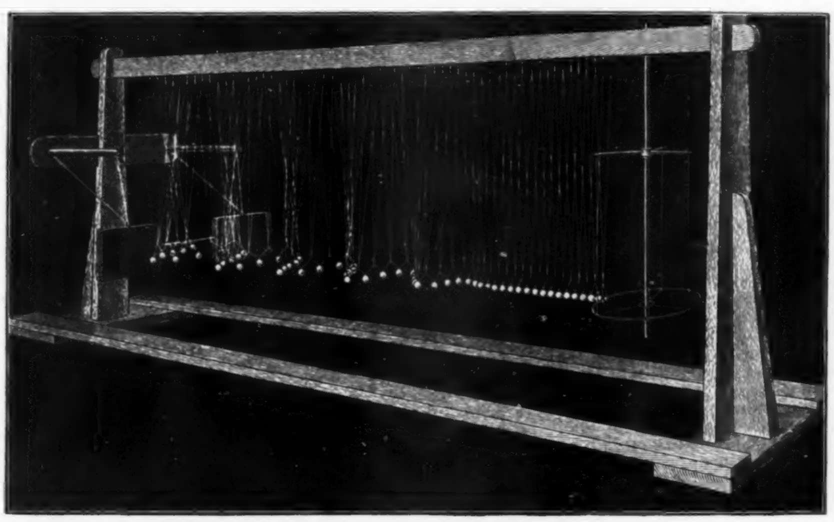
In France boats provided with vivaries are only used for the transportation of lobsters and crayfish. In England, Holland, Denmark, Norway and Germany these boats, however, are in constant use, much attention being paid in these countries to this means of preserving the fish alive. Fish thus taken alive to the markets enjoy a much greater favor in the eyes of the public than fish preserved in ice. These vivariès are either a part of the boat itself or else are large movable basins attached to its sides. In either case, the water is renewed by the progress of the boat, the liquid being communicated to the deck by means of a kind of well in which the action of the swell is felt. A large number of the French fisheries still continue to make use of ice only as a means of taking the fish alive overland. The Société des Pêcheries de l'Océan, for instance, has organized the work in such a manner that the products of the trawling fleet (some five in number) are taken ashore every day by one of the boats, ice being employed only in transit by rail inland.

In the interests of the preservation of the product which they collect, it is to the advantage of the fisheries to employ steamboats, as well as to equip the sailing boats with mechanical haulers. It is not enough that the fish be kept for as short a time as possible in ice; it is also necessary that they remain for as brief a period of time as possible under the water after they have

been captured. Moreover, when the tackle is drawn on board by hand, the fatigue occasioned by the operation is such that the work can hardly be performed more than a limited number of times a day. Hence a mechanical hauler would render the greatest possible service to every trawler that has not yet adopted it, while the resultant gain in money would be considerable.

A HERTZ WAVE MODEL.*

IN the spring of the present year I showed, at a meeting of the Physical Society, of London, a wave motion model which I designed to illustrate mechanically the propagation of a transverse wave. As the exhibition of this model on that occasion, and subsequently at the Royal Society and Royal Institution, has elicited a number of inquiries about the apparatus, it is thought that the following brief account of it may be of some interest to lecturers on physics, particularly at a time when the propagation of electric waves through space is occupying much attention. The apparatus, which is depicted in the accompanying cut, is mounted on a strong wooden frame about two meters long. At one end (the further in the cut) is the "oscillator," a heavy mass of brass hung by two strong V cords from arms which project parallel to the longer dimension of the frame. This mass, which, for the sake of analogy, is quite unnecessarily shaped to imitate an orthodox electric oscillator, can therefore be set swinging in a transverse direction by a suitable impulse given by hand. At the other end of the frame (the nearer in the cut) is the "resonator," a circle of brass wire hung by a tri-filar suspension. Oscillator and resonator must be adjusted by shortening or lengthening the cords so as to have identical periods of oscillation. The real problem in the construction of the apparatus was to find a mechanical means of transmitting the energy of the oscillator in visible waves to the resonator. The means finally adopted was a series of inter-connected pendulums on a plan somewhat similar to one suggested† in 1877 by Prof. Osborne Reynolds. Instead of using springs, however, the requisite inter-connection is obtained by simply suspending the leaden bullets which act as pendulum bobs by V suspensions which overlap, and which, as shown in the cut, are tied together at a point about four centimeters above each of the balls. No ball can be laterally displaced without tending to drag its neighbor also; so that a shearing stress is transmitted along the line of balls. As Reynolds showed twenty years ago, the velocity of propagation of the wave front differs from that of the group of waves, owing to the continual dying away of the amplitude of the advancing waves. This effect, due to the inertia of the medium, is of course equivalent to the presence of dispersion in the medium, waves of different frequencies being propagated with slightly different velocities. So far, therefore, as Prof. Fitzgerald remarked when the model was exhibited, it illustrates the propagation of the wave in a refracting medium rather than in the ether of space. The waves in the model travel quite slowly; and there is a fascination in watching their progress along the row of balls, until they arrive at the resonator and set it into responsive vibration. There is, of course, no attempt made here to represent the magnetic part of the electromagnetic wave at right angles to the electrostatic part; the mechanical displacements in the model corresponding to the electrostatic displacements of the Hertzian wave. A row of inter-connected pendulums such as this affords a means of illustrating many points in physics. For many purposes the elaborate system of suspension by strings may be replaced by a continuous fabric. Thus, for example, a piece of netting, hung on hooks from a horizontal rail, and ending below in a short fringe, with leaden beads on the fringe tips, will also serve to illustrate the propagation of a transverse wave. The structure adopted absolutely refuses to transmit longitudinal disturbances; there being no compressional elasticity between the balls to propagate a longitudinal wave.



MECHANICAL MODEL ILLUSTRATING PROPAGATION OF A HERTZ WAVE.

DIRECT PHOTO-LITHOGRAPHY ON STONE.

IT is rarely attempted to print direct on to the stone, although all the earliest experimenters in the process directed their efforts to this end. It is admitted that there would be considerable gain in a direct print, the loss of sharpness and delicacy by transfer even under the best conditions being sufficiently obvious, but most workers who attempt direct work appear to find the difficulties too great, and fall back on the easier method of paper transfers. Yet it is very probable that, like many other old processes of great practical merit, direct photo-lithography fell into desuetude because those who tried to work it lacked the necessary patience to master the details and conquer the difficulties which always crop up in working a new process.

Recently the writer was led to try a method of direct printing on stone, and found it far from being so difficult as it had been represented, and after two or three attempts a really good print was obtained, possessing a sharpness which could not be got with any transfer method. Afterward the process became comparatively easy as practice was gained. There are many lithographic firms which would be only too glad to find a man who can print direct on stone, and a study of this process may be recommended to young photographers who do not see any very rosy prospect in the present position of portrait photography.

The process we used was based on the published method of Poitevin, but modified as we shall describe. It will be best first to quote the original description, or rather a translated version of it.

Poitevin says: "A hard and close-grained Bavarian lithographic stone is to be preferred. The surface being smoothed and finely grained, I wet it, and having removed the excess of water, I apply with a brush the bichromate mixture, composed of an egg beaten up, passed through a piece of linen, and mixed with an equal quantity of saturated solution of bichromate of ammonia. With a sponge I clean the edges of the stone, and with a linen dabber I remove the excess of solution by dabbing, but without rubbing, and with a drier cloth I remove the remainder of the liquid in the same way until the stone no longer moistens the finger when touched. By working thus, only a very small quantity of the bichromated mixture penetrates into the stone and forms there a very regular inner layer without covering its surface. Without waiting for the complete drying of this layer, I apply to it the photographic cliché, if of paper, by keeping it in place by means of a glass plate fastened down by means of pellets of soft modeling wax. I have also used a special pressure frame to hold the stone and negative, but the way I have described answers ordinarily. If the negative is on glass, I fix it with wax. I expose the prepared stone either to direct sunlight, falling perpendicularly on its surface, or to diffused, laying the stone horizontally. The time of exposure is very variable in summer (from ten to twelve minutes in the sun), and in winter from an hour and a half to two hours; in the shade the exposure will be from four to five times longer. In any case the latitude is great, and it is better to expose too much than too little, because over-exposure can be corrected in the inking of the stone and by the etching and proving, while too little exposure prevents the greasy ink from adhering to the half tones, and that cannot be remedied.

"After exposure to light the stone is taken into the inking room, and there left for some time to take the temperature of the surrounding air, whether it may have been too much warmed or chilled, according to the temperature of the time of year.

"The stone is moistened with a sponge dipped in a solution containing one-third of glycerine to two-thirds of water, and having removed the excess of liquid, I pass a roller charged with transfer ink and varnish all over the stone. The image then appears gradually, the parts which have received the action of light retaining the fatty ink, while the others, corresponding to the whites of the drawing or opaque parts of the negatives, repel it. The stone is damped lightly with ordinary water, and the inking is continued until the drawing has attained the desired strength. If the stone should have been over-inked, the whole is removed with turpentine, the stone is wiped and damped, and the inking-in is done again more carefully with the roller less charged with ink.

"The stone is then left at rest for about twelve hours, in order that the fatty ink may penetrate it and be fixed more completely. It is then gummed. After an hour it is washed, the gum removed, and the stone is then rolled in with ordinary printing ink, etched and proved by pulling a few proofs, just as in the case of an ordinary chalk drawing on stone.

"If the exposure to light has been insufficient, the fatty ink will take with difficulty and the proof will be wanting in half tone; on the contrary, if over-exposed, the image will be heavy and blocked up, but in the majority of cases a good proof is obtained, because there is a great latitude in the exposure if the lithographer is skillful in working up the image. In any case it will always be better to expose a fresh tone rather than to hand over a bad impression to the printer."

It must be noticed that Poitevin is here describing a method of half-tone transfer, and for this reason he speaks of the surface of the stone being finely grained. For a line engraving, or a print from a half-tone negative made with the ruled screen, the smoother the stone is the better, and therefore the polish should be the highest it is possible to obtain, and care should be taken that the stone has been ground quite flat. Any hollows will give trouble. The quality of the stone is of importance, and it should be for preference that rather scarce kind, the gray stone. The yellow stones can be used, but not so easily. The surface of the stone should, of course, be scrupulously clean. Any finger marks would leave a greasy stain which would attract the ink. In coating the stone as described, there would be a difficulty in getting an even film, and the writer prefers to warm the stone in front of a good fire until all the moisture is driven away from the surface of the stone, which then becomes quite warm. The sensitizing solution, exactly the same as used for zinc, is flowed on and spread with a glass rod if it does not flow well.

It is best not to allow any solution to go over the edge of the stone, as it has a tendency to creep back, bringing dust and grit with it, and setting in dirty ridges. The warmth in the stone quickly dries the film, and when quite dry it is ready for exposure. Small stones can be screwed up in a specially made deep printing frame with plate glass front. There is not so much risk of breaking the negative as might be supposed. Poitevin's method of attaching the negative to the stone with pellets of wax is a convenient way, provided the negative glass is flat and the exposure made inside a deep box with blackened sides, so that the light falls perpendicularly.

A better plan is to use stripped film negatives, squeezing them into contact with the stone after having given the latter a light coating of castor oil or vaseline applied on top of the sensitive coating by means of a gelatine roller. The film will then adhere very firmly to the surface; the oil or grease does no harm, as it mingles with the ink when the rolling up comes. The printing does not take so long as Poitevin says. It is, in fact, pretty much the same as for zinc—about three minutes in good sunlight and from fifteen to thirty minutes in diffused light or shade. The temperature of the stone while being inked is quite as important as Poitevin points out. The ink used should be "stone to stone retransfer," applied with a leather roller as stiff as it can be worked. It must be well distributed, and the most delicate coating applied to the stone. Anything like blackness must be avoided; it will simply be an olive gray tint. Then the water from tap or hose pipe is allowed to run over the stone for some minutes, and an indistinct image will be seen. With cotton wool on a soft sponge the surface is gently rubbed until the ink is loosened and comes away. Eventually, if the exposure and other conditions have been correct, a beautifully sharp and black print on the stone will be secured. This is dusted over with very fine resin, and etched with acidulated water, about vinegar strength, after which it is gummed and rolled up in the usual way familiar to all lithographers. The result should be a print very much superior to transferred work, and it will retain its sharpness even during a very long run on the machine. The only drawback is the weight of large stones and the difficulty of handling them in the dark room, but the process has a wide application with small subjects, for which the stones are comparatively light.—Photography.

ON PRACTICALLY AVAILABLE PROCESSES FOR SOLDERING ALUMINUM IN THE LABORATORY.*

IT seems that, ever since the metal aluminum has been used in construction, difficulties have arisen in soldering it. Further, from contemporary literature it appears probable that some perfectly satisfactory methods of getting over the difficulty are known, but not published in sufficient detail to be available.

Hence it seems well to put on record any advance toward the solution of this somewhat troublesome problem. In the first place, my experience is that it is not easy to solder aluminum simply by using an alloy of definite composition without a flux. Also that the only other process which does not require special apparatus, that based upon the use of silver chloride, is very troublesome indeed unless the local fusion of the aluminum be immaterial. I find, however, that cadmium iodide is distinctly more satisfactory. If it be fused on an aluminum plate, decomposition of the salt occurs long before the melting point of the aluminum is reached. The result is generally the violent evolution of iodine vapor and formation of an alloy of cadmium and aluminum on the surface of the metal.

The decomposition of the cadmium iodide is, however, too rapid to be convenient, and the pulverulent white residue is in the way. It is, therefore, of advantage to add some other body which, if possible, will obviate these defects. I find that zinc chloride answers fairly well. Thus I mix concentrated zinc chloride solution with a little ammonium chloride, evaporate in a round porcelain dish, and ignite at a low red heat till a part of the ammonium chloride is volatilized. The fused chlorides are now mixed with cadmium iodide. The proportions of zinc chloride and cadmium iodide are best adjusted experimentally.

The final result, when the salts are completely fused together, is a flux which readily enables tin (or other soldering alloy) to unite perfectly with aluminum. The melted flux can be taken up in a pipette with India rubber teat, and dropped on to the surface of the metal to be soldered. Some powdered metallic tin is also sprinkled on the surface. The aluminum is then heated over the Bunsen flame till the flux just melts; it can then be quickly spread where it is wanted with a piece of copper wire or thin glass rod. As the temperature is further raised the flux decomposes, and the tin readily alloys itself with the surface of the aluminum; while the flux is decomposing, the tin can be spread in a continuous layer by means of the little glass rod or wire.

Instead of cadmium iodide, fused lead chloride may be used in a similar manner.

I should like to substitute some of the less volatile alkyl-ammonium chlorides for the ammonium chloride, but have not had opportunity.

* Silvanus P. Thompson, in Nature.

† See Nature, vol. xvi., p. 343.

* By A. T. Stanton, in Nature.

ENGINEERING NOTES.

Seagoing barges of large capacity are coming into use at Hamburg since the opening of the Baltic-North Sea Canal.

The system of locomotion by machinery is now superseding that of traction by horses, not only in tramway service, but for omnibuses. The Berlin omnibus company is introducing for trial omnibuses propelled by electricity from a secondary battery. The charge is renewed at the two terminal stations.—Uhland's Wochenschrift.

There are in Sweden at the present time 146 furnaces in blast. The production of pig iron, the bulk of which is smelted with charcoal, amounts to 462,930 tons per annum, which represents a daily production of 12·6 tons per furnace. According to The Iron and Coal Trades Review, in 1895 there were in the country 30 Bessemer converters, 33 open hearth furnaces, and 5 crucible steel furnaces.

Statistics show that the number of German and English vessels passing through the Suez Canal is approximately in the same proportion as the size of the corresponding fleets, namely, 1:7. The canal was opened in 1869; in 1870, 486 ships passed through it, in 1896 this number had increased to 3,409. The corresponding increase in tonnage is, however, much greater, the first year's total being 655,000, and that for 1896 being some twenty times as much, namely, 12,000,000. The greatest ships that pass through the canal are the German mail steamers of the East Asiatic Line.—Uhland's Wochenschrift.

The use of acetylene for driving engines is, according to Revue Industrielle, entirely possible, as shown by a series of experiments conducted at Compiegne by Cuinat. It was shown that acetylene develops fully three times the energy of the usual illuminating gas and that the only changes needed to transform an ordinary gas engine into an acetylene engine was a reduction in size of the intake valves. The best mixture was found to be 10 of air to 1 of gas. With these proportions it was found that engines ranging from 8 to 16 h. p. cost about 6 cents per h. p. hour, at the present rate of calcium carbide.

The first cargo of molasses to be sent across the Atlantic Ocean in bulk from this country, it is stated, will be that taken out from Philadelphia by the British tank steamer Petriana. She has been chartered by parties in New York to carry about 600,000 gallons of sirup molasses, which have been purchased from the sugar trust. The port at which the cargo will be landed is London. A great deal of money can be saved, it is said, by shipping it in this way. The cost of cooperage, etc., will be saved, as it will be necessary only to pump the liquid into the vessel's tanks.—Philadelphia Ledger, September 18.

The pipe mills of the Reading Iron Company, probably the largest concern in the United States making black and galvanized iron pipes, have commenced running day and night. One million pounds of pipe, ranging in size from one-eighth of an inch to twelve inches in diameter, are turned out each twenty-four hours. Recently there has been a great influx of foreign orders, and the mills will be kept busy for some time to come making pipe for export to Australia, Africa, England, various countries in the European Continent, Mexico and India. Ten carloads of pipe were consigned to Singapore recently and much more is to follow.

At Toulon the French battleships Brennus, Neptune and Marceau have been engaged in target practice against the hull of the old dispatch boat Pétrel, which was towed with a couple of sails hoisted by the Travailleur, while the Linois, in a position perpendicular to the line of fire, observed the results. She had on board several officers of the squadron as a committee to report, says The Army and Navy Journal. The Brennus discharged twelve rounds from her 13·3 inch guns and eighty from the 6·2 inch guns, the Neptune 100 rounds from her 12·5 inch gun, and the Marceau six rounds from the large guns and 100 from the 5·5 inch quick firers. Thus in all, 298 rounds were discharged at the vessel and at certain targets which were in tow. Very often the shells fell short, but there were many hits, and some of the projectiles went through the boat without causing any serious damage. Others, however, spread destruction where they fell, and the abovewater portions on the port side were almost demolished, while there were some hits below the water line. It was observed, however, that few shells struck the Pétrel between wind and water, but this was accounted for by the great range. The dispatch vessel did not sink, notwithstanding the battering that was given her, but was towed back to Toulon for examination and to be fitted for some further trials toward the end of the month.

We are quite accustomed to see iron or steel arched bridges hinged at the crown and abutments, but to treat a masonry arch in this manner would at first sight appear to be rather venturesome. In Germany, however, several bridges were built some few years ago on this principle, one of them having an effective span of 150 ft., and the result has been quite successful, both from a constructional and from an economical point of view. A complete description of this method of construction was contributed by Mons. G. La Riviere to the Annales des Ponts et Chaussées soon after the bridges were built, and is well worthy of careful perusal. The author draws attention to several curious features in the design of these bridges, but by far the most remarkable is the introduction of the three joints in the masonry ring. These joints, which really act as hinges, are placed one at the crown and one at each abutment, and prevent, of course, the line of pressure deviating very much from the center line of the arch ring, thereby removing all ambiguity as to the actual stresses. The rise of the arches in some cases is not more than 1/15 the span, and no masonry backing is employed, the roadway being supported from the arch by means of thin spandrel or cross walls. The hinged joints are made by inserting sheet lead about ¾ in. thick, extending over only the middle third of the arch stone. At first it was thought that this joint should be made by means of bearing plates and pins, much in the same way as would be done in a steel arch, but this arrangement was subsequently abandoned in favor of the sheet lead.

ELECTRICAL NOTES.

The last horse car line has lately been abolished in Stuttgart (Germany) and electric cars have been substituted. With this all street cars in Stuttgart are now electrically propelled.—Electrotechnische Rundschau.

Suspended railways offer several advantages over the ordinary style of cars. They are less noisy, occupy less space, and have a very gentle motion, which is agreeable to the passengers. Such a line is to be constructed from Dresden (Germany) to the surrounding country; cars are to run every two or three minutes, at a rate of 25 to 30 miles per hour, or, if the stoppages are taken into account, at about 14 to 18 miles per hour.—Electrotechnische Rundschau.

The effect of moisture and heat on electricity insulators is dealt with in a paper read at the recent meeting of electricians at Eliot. In the discussion that followed the reading, Prof. Perrine states that more than 4 per cent. of the total weight of a No. 18 copper cable, covered with paper 0·128 in. thick, can be driven off by evaporating the moisture it contains. Even in dry climates, like that of California, 15 per cent. of the weight of such a paper sheathing is due to moisture. Some specimens of wood were shown which, after being thoroughly dried, had, in three days, added 15 per cent. to their weight by absorbing moisture from the air. Cellulose compounds are unstable at ordinary temperatures, but at 100° they slowly carbonize and fast deteriorate in insulating value.

In the Journal of the Society of Chemical Industry, M. Andreoli remarks that, though theoretically one should be able to produce a kilo of ozone per electric horse power, in practice only ten or twelve grammes are obtained. By improvements, however, in apparatus for the production of ozone, M. Andreoli is now able, he contends, to increase the amount to thirty and in some cases even fifty grammes per horse power, making the cost about 75 cents a kilo. This, if a practical thing applicable on a large scale, is important. Based on these results, experiments are to be made by him in various directions, to ascertain the value of the process in commercial affairs, such as the purification of drinking water, the cleansing of beer casks, preparing wood for instruments and furniture, bleaching of starch and dextrin, oxidation of drying oils, purification of wine and brandy, etc.

According to L'Eclairage Electrique, the Sussmann electric miner's lamp was recently tried in Belgium, and gave very satisfactory results. The accumulator used is one containing a solid electrolyte. An incandescent lamp is fixed above the accumulator, and is inclosed in a special case; the ebonite box, measuring 5 in. by 2⅝ in. by 2⅜ in., is divided into two compartments, each of which holds two negative plates and one positive, which are separated by rubber bands. These plates are pasted; the two cells are connected in series, and give an electromotive force of about 4 volts. The lamp, complete and ready for use, is somewhat heavier than the ordinary miners' lamp, its weight being 4·3 lb. and its capacity 12 to 26 hours, burning under normal conditions, the light given being from two and a half to five times that of an ordinary miners' lamp. The power required for charging was found to be about 3¾ horse power per 100 lamps.

About the surest beacon of prosperity is a sawmill, and when we find one like this at Port Blakely, Wash., than which there is but one other larger in the world and none bigger in the United States, we are inclined to stop to regard it. The whole plant is lighted by electricity, and at present the mill is running night and day, with three shifts of men for the twenty-four hours. Electricity is also used for motive power in the planing and finishing departments and in the blacksmith and pattern shops. Their lathes, planes, moulding, and pattern workings are so complete that they are enabled to supply any portion of disabled machinery at short notice, and last year furnished fifty tons of castings for their own repairs. The company also owns and runs a gristmill for a supply of the logging camps, a hotel for visitors, a hall for public meetings and church purposes, and a town of some 200 houses. Their general store carries a stock complete in every line, from a package of pins to the largest hawsers and cables.

The Antwerp correspondent of The Liverpool Journal of Commerce says that for some time there has been a desire expressed that the electric light should be used for loading and unloading vessels at night, owing to the many serious fires which have taken place at frequent intervals from the upsetting of the old fashioned oil lamps, which have been used since time immemorial. The first experiments with this object in view took place at dock No. 5, five arc lamps being used to light up the quay. When work is not going on, the lamps are hung on arms connected with the cranes; but when a vessel is being worked after dark, the lamps are carried about and hung at points where they can throw the most light into the hold, thus enabling the men to work as in broad daylight, and the custom house officials and tally men take their notes with perfect ease. The danger of fire is reduced to a minimum, and thieving will be less. It is hoped that after this experiment, which has proved so successful, the entire quay system will be furnished with these portable arc lamps.

A very successful and beautiful trial demonstration of the lighting by electricity of the whirlpool rapids of Niagara Falls was given recently, says The Electrical Review, during the conventions in that city and greatly pleased every observer. Special parties of ladies and gentlemen took the Gorge route cars, accompanied by a flat construction car carrying the searchlights and appliances. Current was taken from the trolley wire, six searchlights being supplied, and magnificent color effects were produced on the surging waters by means of the usual color screens. Mr. Luther Stieringer originated the scheme, and through the liberal assistance given by Capt. J. M. Brinker, president of the Gorge road, and Superintendent J. K. Brooks the work was carried to a most successful issue. The apparatus was furnished for the occasion through the courtesy of the General Electric Company. Further private trials are in progress to determine the proper arrangement and quantity of light required to illuminate these rapids in the most effective manner. Numerous requests for the repetition of this novel lighting during the American Street Railway convention in October have been made, and, if possible, will be complied with.

MISCELLANEOUS NOTES.

To distinguish benzine from benzole, add some potassium iodide crystals. Benzole is colored red by this salt, while benzine remains unchanged. If benzole is shaken up with a little alcohol, it turns milky, while benzine does not.—La Science en Famille.

Of two lots of gold from the Klondike received at the New York Assay Office, says the Engineering and Mining Journal, one assayed 0·749 per cent. gold and 0·246 per cent. silver, which made the value $15.48 an ounce, while the other assayed 0·820½ gold and 0·174 silver, making the value $16.95 an ounce.

L. Davy, in Comptes Rendus, cxxv, No. 5, says that all authors who have studied the ancient working of tin in the west of Europe admit that it was far anterior to the occupation of the country by the Romans, and think that the mines of Abbaretz-Nozay were abandoned by the Gauls about the date of the Roman invasion.

An arrangement by which more than one note may be obtained from a single bell is being made by Mr. Shaaber, of Reading, according to a patent granted to him. The device by which he gains this end consists merely of a number of dents, which divide the whole bell into several sections of different sizes. Each section, when struck, gives a note corresponding to its size.—Wiener Gewerbe Zeitung.

Of all postal service, that in East India is the most difficult. There are 4,000 packages monthly which do not reach their destination on account of not bearing any address. The multitude of Hindoo dialects is another great difficulty the postal officials have to contend with, and the postmen are exposed to considerable danger from wild beasts.—Uhland's Wochenschrift.

It is stated in Machinery that acetylene is now in use in several of the Paris omnibuses. The generator weighs about 29 lb., and is carried under the front steps. Each load of carbide is about 0·71 lb., and produces about 3 cubic feet of gas, which is enough for 6½ hours, with a light of 16 candles. The pressure is regulated so as not to exceed 4 in. of water. The cost is less than that of petroleum. Electrical accumulators to do the same work weighed nearly 3 cwt., and did mischief, so that they were glad to give them up.

Herr Nebendahl, of Wandsbeck, Germany, has invented a device for the automatic lighting and extinguishing of street lamps. The working of this apparatus is based on the difference of the pressure at which the gas is supplied during the day and at night, and is so delicate that it is sufficient to have that difference equal to 7 millimeters of mercury. The device consists of a cup containing glycerine, into which dips an inverted bell. This bell is connected to a lever, and by a pipe to the gas conduit. When the pressure of the gas is low the bell is also at a low stand, and the lever admits the gas only to a small lighting flame. When the pressure is raised the bell rises, and the lever opens a cock to the main flame.—Uhland's Wochenschrift.

The management of the French State Railways has obtained the permission of the Minister of Railways for the construction and reconstruction of a number of railway passenger carriages, in which all the parts formerly manufactured of brass, copper and iron, with the exception of axles, wheels, bearings, and springs, brake beams and couplings, shall be constructed of aluminum. The weight of a carriage with aluminum fittings is one and a half tons less than that of an old style carriage. As an ordinary train in France consists of twenty coaches, the weight of the train could be reduced by thirty tons, which would mean a considerable saving in working expenses. It remains to be seen whether aluminum will prove to be as durable as the other metals for the purpose.

E. W. Parker, of the United States Geological Survey, has prepared a report showing in fifteen States the increasing use of coal mining machines from 1891 to 1896. In the former year the amount of coal mined by machines was 2,739,743 tons. This was 3·3 per cent. of the total amount of coal mined that year. Ohio mined 1,654,081 tons by machinery, or over 60 per cent. of the total machine mined coal. In 1896 these fifteen States mined by machinery 12,553,523 tons, which is 13 per cent. of the aggregate output of those States for the year. Ohio increased its machine mined coal from 1,654,081 to 3,368,349 tons, while Pennsylvania increased from 213,402 to 6,092,644 tons. The total output of the fifteen States increased 16 per cent. from 1891 to 1896. The machine mined coal increased 460 per cent. There is no reason to believe that the machines will not be still more widely adopted in the future, since their economy has been demonstrated. While the operation of the machines is easily acquired by a miner, their more general use will tend to increase the average intelligence and skill of the miner.

According to the Pittsburg Dispatch, the largest and most important contract for aluminum ever made has just been closed by the Pittsburg Reduction Company. The contract calls for the delivery in London to the British Aluminum Company of 1,080 tons of aluminum casting ingots at a price aggregating over $750,000. The largest previous contract was one of 80 tons, made some time ago with the German government. This makes Pittsburg the greatest producing center of aluminum in the world. According to the contract, the aluminum will be delivered at the rate of 25 tons per month for the first two years and 20 tons per month for the ensuing two years. The British Aluminum Company has been considered one of the greatest producers of aluminum in Europe, and the placing of such a large contract in the United States is looked upon as significant. The exporting of such great quantities is due to the ingenuity and enterprise of American manufacturers, and places this country at once in the lead of the world. President Alfred E. Hunt, of the Pittsburg Reduction Company, A. W. Mellon, a heavy stockholder in the concern, and J. O. Handy, the principal chemist, are now in Europe, supposedly in connection with the big contract. While the plant of the company is located at Niagara Falls, it is owned by Pittsburgers, and immense benefits are expected to accrue to that city. It is understood the largest part of this shipment of metal will be used for army utensils and buckles for the Russian army.

PRODUCTION OF STATUARY.

THE first thing to settle in a statue or group is the general design. For this purpose the artist, having chosen his subject, makes one or more sketches on paper, representing his conception of the treatment appropriate to it; these he will vary as improvements on the original idea suggest themselves, or as new notions spring up. Having to a certain extent satisfied himself with one or other of them, as expressing fully what he wishes, and as being at the same time harmonious in its arrangement, he then proceeds to make from it a small sketch or model in clay, in order to ascertain its probable effect in other views than the one represented on the paper. For it must be recollected that sculpture is widely different from its sister art, painting; the former has many views to consider, the latter has but one; and though in a piece of sculpture there will, of course, be principal views more effective than others, still they must all be agreeable, and to a certain extent suggestive or expressive of the main idea; and for this reason the sculptor has frequently to sacrifice or modify that which, were only one view to be considered, would aid him forcibly in his intentions. It is scarcely necessary to say, therefore, that alterations occur again in these clay sketches, and more than one is frequently made before the final decision on the question of design takes place. This done, the full size model is commenced in clay, the same material as the sketch, and for this the artist has to supply supports, as it rarely happens, except in recumbent figures, that the clay will hold itself together in the required position without their aid; no difficulty exists, however, in providing these, the roughest hedge carpentering answering the purpose better than the finest workmanship. All that has to be done is to build up upon the stool a rough woodwork of sufficient strength to bear the weight of the clay and prevent it sinking, and to so arrange it that it shall be contained within the surface of the proposed model. Upon this the clay is kneaded by the hand into the requisite form, unassisted by anything but a few very simple wooden tools that help to cut, scrape or press, as may be required. The clay itself is that prepared by the potters for the common white stoneware, and is in no way expensive. Young inexperienced artists often show an overstrong predilection for the use of these wooden spatulas, or modeling tools, as by their assistance they find they can more easily obtain a smooth surface to their work; but experience afterward teaches them that an imitation of the pulpy surface of the flesh can only be obtained from the touch of flesh itself, or, in other words, from the pressure of the finger and thumb, and that the wooden tools must be used sparingly, merely as assistants to the hand, otherwise a hard mechanical style is apt to creep in. There is in truth in a real artist, when working on his clay, the same species of feeling as in a fine pianoforte player, who draws expression from the instrument, not barely from correctness of note, but from a mental absorption in the music which imparts itself to his touch, and this affinity between head and hand is interrupted in the sculptor when the modeling tool intervenes between the surface of his work and the delicate sensation with which his hands are endowed.

With persons unacquainted with sculpture there is a general impression that the cutting of the marble is the most difficult part; but those who are intimate with the art know that the designing and modeling are the primary portions, and that the other, though of course requiring some knowledge as well as taste, is, in comparison, scarcely more than a clever manual dexterity. The artist, in fact, employs his own hand almost entirely on the designs and modeling, for in these stages he has to originate almost all the beauties of his work, and he knows if his model be in any way defective, inaccurate in its proportions or wanting in beauty or expression, that there is no hope that such defects will be remedied in the marble. The latter portion is indeed, in a measure, a mechanical process of copying, restricted, by the very means it employs, from departing to any great extent from the model. Before the model is finished nature must be referred to, and that frequently, to give an air of truth to the figure, which never was and never will be gained except by reference to her. We will, however, suppose that the sculptor has by dint of time and labor thoroughly studied his model, compared it with and corrected it from nature, arranged his draperies and subordinate parts in proper order, brought all the surfaces up to a necessary degree of smoothness, in fact, given to the best of his talent and power actual embodiment of that which his mind has conceived. It is still in the soft clay, which will not bear moving, nor be durable for long, as it is liable to shrinking, and if not constantly supplied with moisture would eventually crack, owing to the supports within not allowing every part to diminish in an equal degree. It has for this reason to be moulded and cast into plaster, a process we shall briefly describe. Plaster of Paris is a strong, fine, white lime, made from gypsum or alabaster ground to powder and baked; and, so prepared, has the property of crystallizing rapidly when mixed with water, or, in other words, of condensing itself into a hard body. A certain quantity is mixed with water, sufficient to form a liquid of about the consistency of good cream, and thrown over a portion of the model, walls of soft clay having been built round that portion in order to prevent it from running on the other parts. The object of thus covering a part only at a time will be seen presently, and the proper division of such parts must be learned by experience, as it depends entirely upon the peculiarities of the model. This liquid plaster of Paris will, under the hands of an experienced workman, take an exact impression of the surface, and in the course of a few minutes become hard, as we have before explained. More must be added, however, in order to render it of the thickness necessary to sustain itself, which thickness will depend on the size of the object to be moulded. The clay walls are then removed, when we have one-half or more of the model covered with a hard shell, the edges of which stand up clean and square from the clay. These edges are then soiled with clay water, and the same process goes on with the other half; or, if it be a very complicated work, there may perhaps be three, four, or even five pieces of mould, all made in this way in succession.

The whole having been covered, after this manner, with a coating, the inner surface of which has taken a delicate impression of every marking on the model, the next step is to open this shell or mould, in order to take out the clay. If the joints between the pieces have been well washed with clay water, these will separate easily by the driving in, at judicious distances, of a few wooden wedges. At any rate, one piece will come away by this means, and from the opening thus made we can pick out the clay, just as it will best come, only taking care not to injure the surface of the mould, as any damage done to that will show itself in the cast. The interior of the mould is now washed with a soft brush and water, and the pieces again put together and bound round with ropes to keep them to their places. The whole is well saturated with water, and fresh plaster of Paris of a finer quality poured into it through the mouth formed by the underneath side of the base. This also, becoming in a few minutes hard, forms a facsimile in plaster of the clay model, to be afterward extracted from the outer casing or mould. Between the surfaces of the two, however, there is but little adhesion, as the saturating the first with water previous to filling it with the second prevents it. The removing the outer coating is accomplished by chipping it off in small pieces by means of a mallet and blunt chisel. This part of the work requires considerable practice as well as caution to prevent injuring the cast; but if everything has been well managed, the pieces will splinter off before the edge of the chisel reaches it. To remedy at last any little faults or inaccuracies that may have occurred, rasps, glass paper, fish skin and for small work Dutch rush are used.

The working of the marble now begins, which, if it require not the highest talent, takes at least the longest time and the greatest labor. The model and marble are fastened in relative positions on two square blocks of stone, having each, along the edge in front, a scale of parts marked out, similar to those on a carpenter's rule. The "pointing instrument," as it is called, is then applied, which consists generally of an upright pole, with a cross piece attached, that travels along the edge so marked, just as a T-square travels along the edge of a drawing board. (This pointing instrument may indeed be well conceived by fancying a large T-square, the long part round instead of flat and perpendicular instead of horizontal.) To this is attached a circular metal bar, and at the end of that again a needle, with ball and socket joints between both. By the aid of these joints the workman can fix the point of the needle to any part of his model, and having by means of the screws tightened the joints, can transfer the instrument from the stone on which the model rests to the other, when of course the relative position of that part in the marble will be indicated if the instrument itself be fixed to the corresponding number on the scale. It is, in fact, nothing more than a system of finding a third point from two already given. Various improvements have from time to time been made on this instrument in order to gain facility of motion, but the principle in all is the same. The best one is, perhaps, that invented by Behnes, for which the Society of Arts awarded its gold medal. It possesses greater variety of movement than any other, and, as such, is more convenient to the workman, but has one drawback—a too great liability to get out of repair. Indeed, it will be easily understood that in an operation where dust and small pieces of marble are constantly flying about, it is not advisable to have to do with machinery of too delicate a construction. By this simple method the block is hewn out roughly, but correctly, into shape, and a great number of points or perforations are made in it, the bottom of which represent the surface of the model, and correspond in distance from each other with small pencil dots, marked at the time of taking them upon the model. These marks on marble and model form so many guides for the carver who now takes the work in hand, so that his mind is entirely relieved from the apprehension of any error in the main proportions or position of parts, these being definitely fixed by the points themselves. He has merely to copy what he sees correctly, by the aid of these points, and to bring the whole to a good fine surface; his ingenuity is displayed in clearing out with his chisel and hand drill the deep cuttings—often a very difficult task, attended not only with a great deal of labor, but requiring considerable skill as well as practice. The marble comes at last again into the artist's studio, from whence the model emanated; and his delight is then in giving those final touches which remove from it any hardness or immobility it may have acquired under the hands of a copier and impart to it the spirit and character of nature. The whole is ultimately rubbed over with sand and water by the aid of small pieces of wood and linen rags, to remove the dry, dusty appearance derived from the chisel or rasp and to bring up the lucid beauty of the material.

When the multiplying of casts is required, as is frequently the case, a mould is again made upon the finished marble, much after the fashion previously described with the clay, but composed of an immense number of pieces, fitting one within the other, so as to admit of each one coming away separately from the marble, and, again, from the casts, without injury to either.

This is professionally termed "safe moulding," on account of the outer coating being preserved; in opposition to the other, which is called "waste moulding," from the shell or mould being destroyed in the process. Any reasonable number of casts may be taken from the safe moulds.

Bronze casting is another distinct process, little understood by artists themselves, and requiring, moreover, considerable accommodation in the way of premises, furnaces, apparatus, etc. For these reasons it is frequently intrusted to regular trade founders, who understand well enough the moulding and melting of metals, but who cannot be expected to comprehend the niceties required in a good work of art. The consequence is, in this country at least, that considerable deterioration often takes place; the bronze casting representing but imperfectly the form of the original model. The practice in these ordinary foundries is to mould the parts of a statue in sand and loam, after the manner of common metal castings, and without doubt much expense is thereby saved; but the result is never quite satisfactory, as these materials are not fine enough to take a sharp expression, nor stable enough to retain it uninjured during the operation of building the core and pouring the metal, owing to which many parts of the mould have to be repaired by the workman, and accuracy to the model is lost. In engineer's work castings are all afterward made true by planing, turning, filing, etc., so that, provided they be sound, it is not positively necessary that they should be in every respect accurate. Not so with fine art bronzes. Chasing—in fact, all tool work on the metal—tends to destroy all freedom of manipulation, and to produce in its stead a stiff, mechanical style, the reverse of all semblance to flexibility. It is desirable, therefore, that a bronze statue should be cast from the mould as perfect as can be, and that it be subject as little as possible to the operation of the chaser's chisels and punches, though of course these must be brought into use, to a certain extent, as matters of necessity rather than choice.

Moulding for bronze requires frequently that the plaster model should be cut into parts. It rarely happens, in fact, that a statue or group can be cast in one piece, owing to difficulties that arise, first from the moulding itself, and secondly from the running of the metal into that mould. It will not be requisite to describe the moulding of these pieces, as the process is similar to that previously performed on the clay, with some modifications necessary to suit the nature of metals. There are, however, two or three points which require especial care and attention, and which regulate many of the contrivances adopted in it, and by alluding to these we shall at once enable the reader, aided by what has already been said, to understand the whole business. One of them is the necessity for fully providing for the free entrance of the liquid metal into the mould, as well as for the easy and perfect escape of the air out of it, as it becomes displaced by the metal; for, without proper arrangement for this there is not the slightest chance of the cast being sound, and explosions may take place, destructive not only of the work, but even of life itself. For this reason channels have to be made in the joints of the mould down which the metal is first made to run, whence, entering the vacancy left to form the cast at the lowest point, it rises upward through all the parts, and the air can thus easily escape through other channels cut for that purpose. It should be here mentioned for the benefit of those unacquainted with the nature of metal casting that there must always be provided an inner mould, or as it is termed a core, to regulate the thickness of the metal. This is managed by laying on the surface of the outer mould clay of the required thickness, and then filling up the interior with the same material as the mould itself, after which the outer mould is removed and the clay taken away, leaving the necessary vacancy for the metal between the two when they are again put together. The material to form the mould and core must be of a consistency to retain the impression given to it from the model, of a nature to resist the action of the hot metal and sufficiently porous to allow the escape of gas, without which the liquid fire will not settle quietly and soundly down on its surface. Sand moulds act well as far as the last two are concerned, but are too fragile for the complicated forms of statue moulding, and experience has taught us that a mixture in equal proportions of plaster of Paris and brickdust serves best all purposes, the former giving it consistency and the latter answering all desiderata with regard to the metal. These brickdust and plaster moulds are, of course, tender, and must, therefore, be duly supported with irons embedded within them, as well as built upon iron basements, to enable them to be lifted about without injury by means of cranes. When complete they are bound round by iron hoops, and put into an oven to dry for five or six weeks, according to their size. Care in this particular is highly important, as the least damp will cause a bubbling or disturbance of the metal as it runs in. At the end of this time, when the casting takes place, the mould is lowered into a pit prepared for the purpose, and tightly embedded in sand. Weights are put upon the top to prevent the uprising of any part as the metal enters. Every precaution, in fact, is taken against expansion. Channels are then made of sand from the orifice of the furnace to the mouth of the mould; the furnace is tapped, and the liquid flame rushes out through the roads so formed for it. This is the anxious moment upon which the result of many weeks' work depends. If the metal run quietly down the mould, and appear again up the passages formed for the escape of the air, it is but reasonable to infer that it has traveled through every part, and that a good cast will be the result. But if by chance a beautiful jet-de-feu takes place, reaching almost to the foundry roof, it may be as well to retire to a respectful distance, notwitstanding that the dispersion of so much valuable metal may create a desire to see where it falls. The moulder, too, may recommence his work immediately, for waiting until to-morrow, when the mould and cast are to be dug out of the pit, will be scarcely worth while.

No bronze mould can serve for more than once, and the cast will be found to have a strong resemblance to a honeycomb, very curious, no doubt, but not exactly suited to display clear definition of form. Such noisy and expensive fireworks do not, however, take place in a well managed affair, where there is everything proper for use and every care taken. But the mention of them may serve to caution those who have not the means at hand to do what is right, or who meddle with the process without the necessary knowledge or experience to guide them. Some variety of opinion exists on the question of what this metal called bronze should be composed; but the late Mr. Maudsley, no mean authority, declared 91 of copper to 9 of tin to be the best mixture for figure casting, and his opinion has certainly been found correct. An addition of about one and a half of zinc, put in when the copper is melted, makes it flow more freely. But a greater quantity than this is scarcely justifiable, as zinc is liable to be acted upon by acids, and, if used too freely, may endanger the durability of the statue. The mould comes off from the cast in dry dust, as does also the core from the inside. The parts called runners, formed on the cast by the metal filling up the passages through which it has flowed, and the projecting lines, caused by the seams or joints, have then to be cut off, and any little defects remedied by the chasing tools. The whole should then be scrubbed with emery and water to remove a green scurf attached to it, the presence of which is, however, a sure indication of a good surface beneath. The last proceeding is to join the various parts so cast. This is done by first fastening them together by bolts, and then pouring hot metal from a crucible over the joint,

POLAR BEARS FIGHTING.

6 or 7 inches at a time, when embedded in sand so as to expose nothing but the edges required to be united. When cool this leaves a piece of metal standing up, to be afterward cut away. A repetition of this operation, all along the joint, will be found to unite the parts as solidly as if cast at one time, and will not be at all visible in the finished work. The statue is then complete. Attempts, it is true, are sometimes made to give an artificial color to the metal, by means of acids, before it leaves the foundry; but time does that better than anything else.—The Architect and Contract Reporter.

A FIGHT OF POLAR BEARS.

THE scene brought before us in our illustration shows an intensely critical moment. Two polar bears have attacked each other in a quarrel, probably over some morsel of food, and in their struggle have rolled to the edge of their bath. Here the bear who has secured the upper hand holds the apparently weaker one gripped by the throat and plunges him heavily into the familiar element. The conqueror has his vanquished foe practically at his mercy, nor does the fierce glow of his eyes speak of sparing pity.

Meanwhile the noise of the conflict has called the keepers to the spot, and, dreading the loss of one of their finest specimens, they exert all that is in their power to separate the furious beasts. Poles, spikes, large pieces of timber and heavy stones are the most handy means of distracting the bears' attention from their private enmity. It seems, indeed, that the stone which is just flying in midair at the moment which our cut represents must needs make some impression on the combatant it is aimed at. However, here lies the critical question, the thread on which hangs the fate of the victim. We leave it to our readers to decide whether it shall live or die.

The whole scene carries an impression of giant strength let loose, of huge masses tossed by irresistible powers. This effect is yet heightened by the clumsy bulk of the bears' bodies, their fiercely sparkling eyes and the gaping mouth beset with fearful teeth of the defeated foe.—For our engraving we are indebted to Der Zoologische Garten.

A HAND-SHAPED CARROT.

WE reproduce herewith, from La Nature, a figure of a vegetable curiosity in the form of a hand-shaped carrot which was gathered by a farmer at Boisnithum, near Boulogne-sur-Mer. It will be remarked that the five fingers of the hand are clearly delineated. Some of them doubtless, such as the index and middle finger, have a somewhat irregular form, but there neverthe-

HAND-SHAPED CARROT.

less exist proportions among all of them that make them resemble the fingers of the human hand.

COMMON PLANTS.

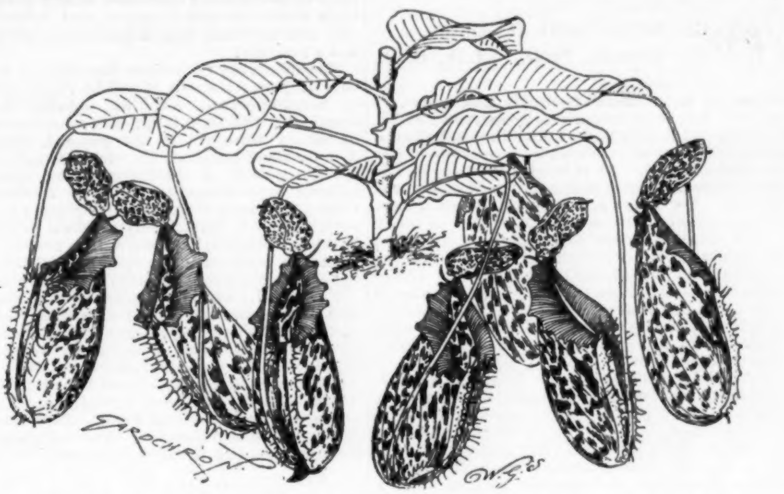
EVERY nurseryman's catalogue gives an important place to its list of rare plants, and, of course, the prices of trees and shrubs and herbs which are scarce are higher than those which afford an ample stock to draw upon. This is simply in obedience to the law of supply and demand, which in a general way regulates the prices of every commodity which man desires for use or ornament. In the eye of some persons, however, rare plants are invested with a value which does not belong to them instrinsically. One who has acquired the habit or passion for collecting places the highest value on objects which are unique. A first edition or the only known copy of a book which in itself is nearly worthless may be a prize for which a book collector will give a small fortune; and in the same way an orchid which is the only individual of its species known will command a price quite out of proportion to any charm it may have of form or color or fragrance. The case of one who is studying a given genus of plants is somewhat similar. He may want an iris, for example, to complete his series, and to him the missing plant has an importance that would not belong to it under any other conditions.

All this is readily comprehensible, but there are other people who have a feeling somehow that rarity is in itself an element of beauty in a plant; at all events, if they would not state this broadly, they firmly believe in its converse, namely, that a plant which is common is not desirable. It is this idea which lies at the root of the distinction between "common trees" and "ornamental trees" which we so often hear. This notion was once so prevalent that it was a difficult thing a few years ago to find common American forest trees and shrubs for sale in American nurseries. When Central Park was planted it was easy enough to buy European birches, Norway maples and horse-chestnuts, but few nurseries had our own canoe birch or pin oak or pepperidge. English hawthorns could be had by the hundred, but many of our native thorns were not propagated at all. Spiræas and Kerrias and honeysuckles from abroad could be had by the thousand, but our native honeysuckles and many of the best of the Viburnums and other American shrubs were not classed as ornamental plants at all. Conditions have changed since then somewhat, and the herbaceous plants and shrubs and trees which grow in our own forests and along our waysides have been more freely admitted into the aristocratic society of their foreign relatives, and the fact that a plant is common is not always a reproach to it.

Different plants have different values to planters according to the use that is made of them. Landscape gardening wherever it is practiced over areas of considerable extent deals properly with scenery; that is, with the permanent features of the land—its roll of surface, its sky-line and distance. The greatest artist in landscape is one who with these fundamental elements and the common trees and shrubs and grass makes a picture which is a unit, and every portion of which helps consistently to give expression to a central idea. This differs entirely from what is called decorative gardening, which is concerned more especially with the detailed ornamentation of more limited spaces. For decorative purposes plants and flowers may be grouped into arrangements which kindle admiration on account of their symmetry of form and richness of color. This is the presentation of beauty for its own sake. It appeals to the æsthetic sense alone and not to the imagination, and through it to our higher nature as a landscape picture does. It is not necessary that a decorative group should be in any sense natural, and plants with foliage of strong color or those that can be trained into peculiar shapes or which have an unusual habit are often the most valuable in such places. They are useful just as stones of different form and color are useful in a mosaic. In decorative gardening a plant of golden elder or of Prunus pissardi may have the highest value, while the same plants in a natural landscape would be worse than useless, and, indeed, might ruin a quiet picture by their obtrusiveness.

There is another kind of gardening, however, which has been called specimen gardening, and which has many attractions to lovers of plants. To such persons a garden exists for its plants rather than the plants for the garden. It is not a landscape picture that is desired, nor yet geometrical designs of pleasing form and color. It is individual plants that are cherished irrespective of their arrangement, and they may be selected for their rarity or their oddity, or for any other quality that appeals to the fancy of the planter. This makes a pleasant diversion, but it is by no means the highest form of gardening. A wise observer once said that it marked a distinct decline in garden art when a gentleman led you to a point on his estate where he could show you the finest Cryptomeria in England, instead of conducting you to the point where you might see the most delightful view.

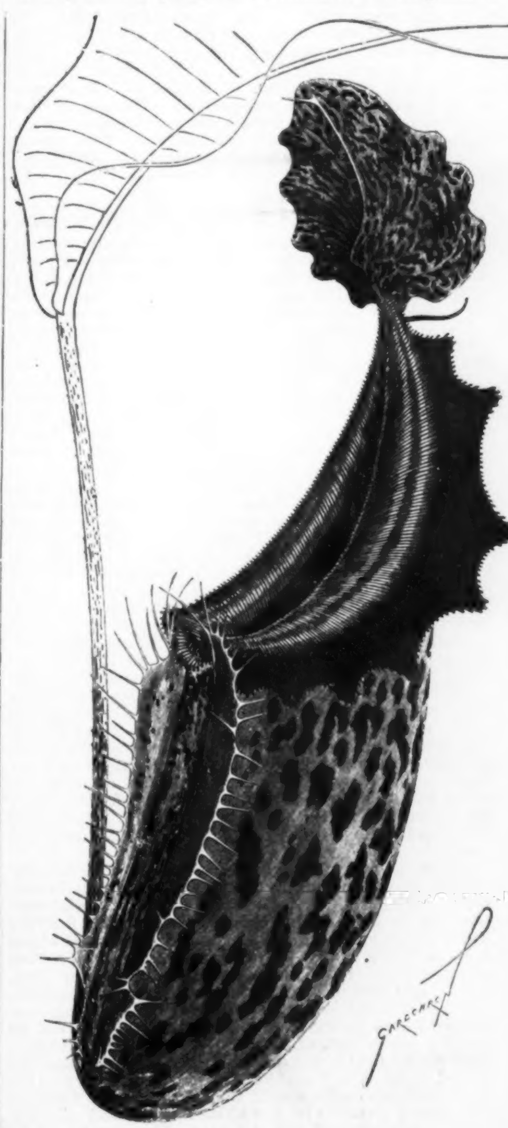
But we have wandered from our purpose. We set out to make a mild protest against the idea that a plant is not desirable if it is common. A great patron of horticulture once declared that he could get up no enthusiasm for lilacs because they could be seen at every farm-house door. Now, since there are hundreds of varieties of the common lilac and many distinct species besides, there is opportunity for gathering a collection of these shrubs, which represent a wide diversity of habit as well as in the form and color of their flowers—many of them rare plants which never graced a farmer's yard. But the common lilac itself will always be a desirable shrub. It has such intrinsic merit that it cannot be vulgarized by mere abundance. Its habit of growth, the graceful way in which its dense panicles of flowers are carried above the thick leaves, their exquisite color, which has no exact duplicate in the vegetable kingdom; the fragrance, which is their own and unmistakable, will always make this a useful plant. It is hardy, long-lived, and will endure abuse; it is often found by a wayside cabin without a single companion, and yet it is beautiful enough to have been the chief ornament of the home of one of our great poets. It is admired because of its many good qualities, and it will be more and more valued for association by every succeeding generation of plant lovers. The fact is, that for all practical purposes the cheapest plants are the best. Among the novel introductions every year there are some that will stand the test of time, and as soon as they demonstrate their usefulness they will be common. In order to be widely useful a plant must be easily propagated, it must be hardy and long-lived, and these are qualities that will ultimately make it cheap, just as the Tartarian honeysuckle is cheap, although one of the most beautiful and indispensable of shrubs. Grass is common, but it is an unfailing refreshment to the eye, and it is so universally appreciated that no one considers Ruskin's glowing description pitched on too high a key. No novice need be deterred from planting trees or shrubs on account of the high price of novelties or rarities. If his purse will allow him to import the most expensive sorts, he may find pleasure in gratifying his desires in this direction, but if he buys no others he will discover at last that he has but a sickly lot of incongruities. He will learn that the common plants are the basis of every good collection, and that cheap plants are the most effective in producing pictures which are impressive and permanent.—Garden and Forest.



A PLANT OF NEPENTHES × TIVEYI—PITCHERS COLORED BROWN AND GREEN.

NEPENTHES × TIVEYI.

OUR illustrations represent a full-sized pitcher and the plant as it appears at the present time, of a new hybrid of Nepenthes raised at the Royal Exotic Nursery, Chelsea, and exhibited at the Royal Horticultural Society's meeting held at Westminster. The plant is the result of a cross between the species N. Curtisii and N. Veitchi. The ground color of the body of the pitcher is of a light green, streaked and blotched with a bright brown tint, as is likewise the prolongation of the midrib of the leaf on which the pitcher depends. A conspicuous feature is the broad, convex rim of the pitcher, which is of bright reddish brown, running into



PITCHER OF NEPENTHES × TIVEYI.

a lighter shade toward the inner edge, and beautifully lined. The operculum or lid resembles the rest of the pitcher in regard to the ground color and markings; the wings are green, and possess a few long hairs. The pitchers in general partake of the characteristics of both parents—N. Veitchi, a Bornean species of great beauty, going sometimes under the names of villosa and sanguinea. We are indebted to the Gardeners' Chronicle for the cuts and particulars.

AN UNDISCOVERED GAS.*

By Prof. WILLIAM RAMSAY, Ph.D., LL.D., Sc.D., F.R.S.

THE subject of my remarks to-day is a new gas. I shall describe to you later its curious properties; but it would be unfair not to put you at once in possession of the knowledge of its most remarkable property—it has not yet been discovered. As it is still unborn, it has not yet been named. The naming of a new element is no easy matter. For there are only twenty-six letters in our alphabet, and there are already over seventy elements. To select a name expressible by a symbol which has not already been claimed for one of the known elements is difficult, and the difficulty is enhanced when it is at the same time required to select a name which shall be descriptive of the properties (or want of properties) of the element. It is now my task to bring before you the evidence for the existence of this undiscovered element.

It was noticed by Döbereiner, as long ago as 1817, that certain elements could be arranged in groups of three. The choice of the elements selected to form these triads was made on account of their analogous properties, and on the sequence of their atomic weights, which had at that time only recently been discovered. Thus calcium, strontium and barium formed such a group; their oxides, lime, strontia, and baryta, are all easily slaked, combining with water to form soluble lime water, strontia water and baryta water. Their sulphates are all sparingly soluble, and resemblance had been noticed between their respective chlorides and between their nitrates. Regularity was also displayed by their atomic weights. The numbers then accepted were 20, 42·5 and 65; and the atomic weight of strontium, 42·5, is the arithmetical mean of those of the other two elements, for $(65 + 20)/2 = 42·5$. The existence of other similar groups of three was pointed out by Döbereiner, and such groups became known as "Döbereiner's triads."

Another method of classifying the elements, also depending on their atomic weights, was suggested by Pettenkofer, and afterward elaborated by Kremers, Gladstone and Cooke. It consisted in seeking for some expression which would represent the differences between the atomic weights of certain allied elements. Thus the difference between the atomic weight of lithium, 7, and sodium, 23, is 16; and between that of sodium and of potassium, 39, is also 16. The regularity is not always so conspicuous. Dumas, in 1857, contrived a somewhat complicated expression which, to some extent, exhibited regularity in the atomic weights of fluorine, chlorine, bromine and iodine; and also of nitrogen, phosphorus, arsenic, antimony and bismuth.

The upshot of these efforts to discover regularity was that, in 1864, Mr. John Newlands, having arranged the elements in eight groups, found that when placed in the order of their atomic weights, "the eighth element, starting from a given one, is a kind of repetition of the first, like the eighth note of an octave in music." To this regularity he gave the name "The law of octaves."

The development of this idea, as all chemists know, was due to the late Prof. Lothar Meyer, of Tübingen, and to Prof. Mendeleeff, of St. Petersburg. It is generally known as the "Periodic Law." One of the simplest methods of showing this arrangement is by means of a cylinder divided into eight segments by lines drawn parallel to its axis; a spiral line is then traced round the cylinder, which will, of course, be cut by these lines eight times at each revolution. Holding the cylinder vertically, the name and atomic weight of an element is written at each intersection of the spiral with a vertical line, following the numerical order of the atomic weights. It will be found, according to Lothar Meyer and Mendeleeff, that the elements grouped down each of the vertical lines form a natural class; they possess similar properties, form similar compounds, and exhibit a graded relationship between their densities, melting points and many of their other properties. One of these vertical columns, however, differs from the others, inasmuch as on it there are three groups, each consisting of three elements with approximately equal atomic weights. The elements in question are iron, cobalt and nickel; palladium, rhodium and ruthenium; and platinum, iridium and osmium. There is apparently room for a fourth group of three elements in this column, and it may be a fifth. And the discovery of such a group is not unlikely, for when this table was first drawn up Prof. Mendeleeff drew attention to certain gaps, which have since been filled up by the discovery of gallium, germanium and others.

The discovery of argon at once raised the curiosity of Lord Rayleigh and myself as to its position in this table. With a density of nearly twenty, if a diatomic gas, like oxygen and nitrogen, it would follow fluorine in the periodic table; and our first idea was that argon was probably a mixture of three gases, all of which possessed nearly the same atomic weights, like iron, cobalt and nickel. Indeed, their names were suggested, on this supposition, with patriotic bias, as Anglium, Scotium and Hibernium! But when the ratio of its specific heats had, at least in our opinion, unmistakably shown that it was molecularly monatomic, and not diatomic, as at first conjectured, it was necessary to believe that its atomic weight was 40, and not 20, and that it followed chlorine in the atomic table, and not fluorine. But here arises a difficulty. The atomic weight of chlorine is 35·5 and that of potassium, the next element in order in the table, is 39·1; and that of argon, 40, follows, and does not precede, that of potassium, as it might be expected to do. It still remains possible that argon, instead of consisting wholly of monatomic molecules, may contain a small percentage of diatomic molecules; but the evidence in favor of this supposition is, in my opinion, far from strong. Another possibility is that argon, as at first conjectured, may consist of a mixture of more than one element; but, unless the atomic weight of one of the elements in the supposed mixture is very high, say 82, the case is not bettered, for one of the elements in the supposed trio would still have a higher atomic weight than potassium. And very careful experiments, carried out by Dr. Norman Collie and myself, on the fractional diffusion of argon, have disproved the existence of any such element with high atomic weight in argon, and indeed have practically demonstrated that argon is a simple substance, and not a mixture.

The discovery of helium has thrown a new light on this subject. Helium, it will be remembered, is evolved on heating certain minerals, notably those containing uranium; although it appears to be contained in others in which uranium is not present, except in traces. Among these minerals are clevéite, monazite, fergusonite, and a host of similar complex mixtures, all containing rare elements, such as niobium, tantalum, yttrium, cerium, etc. The spectrum of helium is characterized by a remarkably brilliant yellow line, which had been observed as long ago as 1868 by Profs. Frankland and Lockyer in the spectrum of the sun's chromosphere, and named "helium" at that early date.

The density of helium proved to be very close to 2·0, and like argon, the ratio of its specific heat showed that it, too, was a monatomic gas. Its atomic weight therefore is identical with its molecular weight, viz., 4·0, and its place in the periodic table is between hydrogen and lithium, the atomic weight of which is 7·0.

The difference between the atomic weights of helium and argon is thus 36, or 40—4. Now there are several cases of such a difference. For instance, in the group the first member of which is fluorine we have—

Fluorine	19	
Chlorine	35·5	16·5 19·5
Manganese	55	

In the oxygen group—

Oxygen	16	
Sulphur	32	16 20·3
Chromium	52·3	

In the nitrogen group—

Nitrogen	14	
Phosphorus	31	17 20·4
Vanadium	51·4	

And in the carbon group—

Carbon	12	
Silicon	28·3	16·3 19·8
Titanium	48·1	

These instances suffice to show that approximately the differences are 16 and 20 between consecutive members of the corresponding groups of elements. The total differences between the extreme members of the short series mentioned are—

Manganese—fluorine	36
Chromium—oxygen	36·3
Vanadium—nitrogen	37·4
Titanium—carbon	36·1

This is approximately the difference between the atomic weights of helium and argon, 36.

There should, therefore, be an undiscovered element between helium and argon, with an atomic weight 16 units higher than that of helium, and 20 units lower than that of argon, namely, 20. And if this unknown element, like helium and argon, should prove to consist of monatomic molecules, then its density should be half its atomic weight, 10. And pushing the analogy still farther, it is to be expected that this element should be as indifferent to union with other elements as the two allied elements.

My assistant, Mr. Morris Travers, ha indefatigably aided me in a search for this unknown gas. There is a proverb about looking for a needle in a haystack; modern science, with the aid of suitable magnetic appliances, would, if the reward were sufficient, make short work of that proverbial needle. But here is a supposed unknown gas, endowed no doubt with negative properties, and the whole world to find it in. Still, the attempt had to be made.

We first directed our attention to the sources of helium—minerals. Almost every mineral which we could obtain was heated in a vacuum, and the gas which was evolved examined. The results are interesting. Most minerals give off gas when heated, and the gas contains, as a rule, a considerable amount of hydrogen, mixed with carbonic acid, questionable traces of nitrogen, and carbonic oxide. Many of the minerals, in addition, gave helium, which proved to be widely distributed, though only in minute proportion. One mineral—malacone—gave appreciable quantities of argon; and it is noteworthy that argon was not found except in it (and, curiously, in much larger amount than helium) and in a specimen of meteoric iron. Other specimens of meteoric iron were examined, but were found to contain mainly hydrogen, with no trace of either argon or helium. It is probable that the sources of meteorites might be traced in this manner, and that each could be relegated to its particular swarm.

Among the minerals examined was one to which our attention had been directed by Prof. Lockyer, named eliasite, from which he said that he had extracted a gas in which he had observed spectrum lines foreign to helium. He was kind enough to furnish us with a specimen of this mineral, which is exceedingly rare, but the sample which we tested contained nothing but undoubted helium.

During a trip to Iceland in 1895 I collected some gas from the boiling springs there. It consisted, for the most part, of air, but contained somewhat more argon than is usually dissolved when air is shaken with water.

In the spring of 1896 Mr. Travers and I made a trip to the Pyrenees to collect gas from the mineral springs of Cauterets, to which our attention had been directed by Dr. Bouchard, who pointed out that these gases are rich in helium. We examined a number of samples from the various springs, and confirmed Dr. Bouchard's results, but there was no sign of any unknown lines in the spectrum of these gases. Our quest was in vain.

We must now turn to another aspect of the subject. Shortly after the discovery of helium, its spectrum was very carefully examined by Profs. Runge and Paschen, the renowned spectroscopists. The spectrum was photographed, special attention being paid to the invisible portions, termed the "ultra-violet" and "infra-red." The lines thus registered were found to have a harmonic relation to each other. They admitted of division into two sets, each complete in itself. Now, a similar process had been applied to the spectrum of lithium and to that of sodium, and the spectra of these elements gave only one series each. Hence, Profs. Runge and Paschen concluded that the gas, to which the provisional name of helium had been given, was, in reality, a mixture of two gases, closely resembling each other in properties. As we know no other elements with atomic weights between those of hydrogen and lithium, there is no chemical evidence either for or against this supposition. Prof. Runge supposed that he had obtained evidence of the separation of these imagined elements from each other by means of diffusion; but Mr. Travers and I pointed out that the same alteration of spectrum, which was apparently produced by diffusion, could also be caused by altering the pressure of the gas in the vacuum tube; and shortly after Prof. Runge acknowledged his mistake.

These considerations, however, made it desirable to subject helium to systematic diffusion, in the same way as argon had been tried. The experiments were carried out in the summer of 1896 by Dr. Collie and myself. The result was encouraging. It was found possible to separate helium into two portions of different rates of diffusion, and consequently of different density, by this means. The limits of separation, however, were not very great. On the one hand, we obtained gas of a density close on 2·0; and on the other, a sample of density 2·4 or thereabout. The difficulty was increased by the curious behavior, which we have often had occasion to confirm, that helium possesses a rate of diffusion too rapid for its density. Thus, the density of the lightest portion of the diffused gas, calculated from its rate of diffusion, was 1·874; but this corresponds to a real density of about 2·0. After our paper, giving an account of these experiments, had been published, a German investigator, Herr A. Hagenbach, repeated our work and confirmed our results.

The two samples of gas of different density differ also in other properties. Different transparent substances differ in the rate at which they allow light to pass through them. Thus, light travels through water at a much slower rate than through air, and at a slower rate through air than through hydrogen. Now Lord Rayleigh found that helium offers less opposition to the passage of light than any other substance does, and the heavier of the two portions into which helium had been split offered more opposition than the lighter portion. And the retardation of the light, unlike what has usually been observed, was nearly proportional to the densities of the samples. The spectrum of these two samples did not differ in the minutest particular; therefore it did not appear quite out of the question to hazard the speculation that the process of diffusion was instrumental, not necessarily in separating two kinds of gas from each other, but actually in removing light molecules of the same kind from heavy molecules. This idea is not new. It had been advanced by Prof. Schützenberger (whose recent death all chemists have to deplore), and later by Mr. Crookes, that what we term the atomic weight of an element is a mean; that when we say that the atomic weight of oxygen is 16, we merely state that the average atomic weight is 16; and it is not inconceivable that a certain number of molecules have a weight somewhat higher than 32, while a certain number have a lower weight.

We therefore thought it necessary to test this question by direct experiment with some known gas; and we chose nitrogen, as a good material with which to test the point. A much larger and more convenient apparatus for diffusing gases was built by Mr. Travers and myself, and a set of systematic diffusions of nitrogen was carried out. After thirty rounds, corresponding to 180 diffusions, the density of the nitrogen was unaltered, and that of the portion which should have diffused most slowly, had there been any difference in rate, was identical with that of the most quickly diffusing portion, i. e., with that of the portion which passed first through the porous plug. This attempt, therefore, was unsuccessful; but it was worth carrying out, for it is now certain that it is not possible to separate a gas of undoubted chemical unity into portions of different density by diffusion. And these experiments rendered it exceedingly improbable that the difference in density of the two fractions of helium was due to separation of light molecules of helium from heavy molecules.

The apparatus used for diffusion had a capacity of about two liters. It was filled with helium, and the operation of diffusion was carried through thirty times. There were six reservoirs, each full of gas, and each was separated into two by diffusion. To the heavier portion of one lot, the lighter portion of the next was added, and in this manner all six reservoirs were successively passed through the diffusion apparatus. This process was carried out thirty times, each of the six reservoirs having had its gas diffused each time, thus involving 180 diffusions. After this process, the density of the more quickly diffusing gas was reduced to 2·02, while that of the less quickly diffusing had increased to 2·27. The light portion on rediffusion hardly altered in density, while the heavier portion, when divided into three portions by diffusion, showed a considerable difference in density between the first third and the last third.

A similar set of operations was carried out with a fresh quantity of helium, in order to accumulate enough gas to obtain a sufficient quantity for a second series of diffusions. The more quickly diffusing portions of both gases were mixed and rediffused. The density of the lightest portion of these gases was 1·98; and after other fifteen diffusions, the density of the lightest portion had not decreased. The end had been reached; it was not possible to obtain a lighter portion by diffusion. The density of the main body of this gas is therefore 1·98; and its refractivity, air being taken as unity, is 0·1245. The spectrum of this portion does not differ in any respect from the usual spectrum of helium.

As rediffusion does not alter the density or the refractivity of this gas, it is right to suppose that either one definite element has now been isolated; or that if there

* Address before the chemical section of the British Association for the Advancement of Science.

are more elements than one present, they possess the same, or very nearly the same, density and refractivity. There may be a group of elements, say three, like iron, cobalt, and nickel; but there is no proof that this idea is correct, and the simplicity of the spectrum would be an argument against such a supposition. This substance, forming by far the larger part of the whole amount of the gas, must in the present state of our knowledge be regarded as pure helium.

On the other hand, the heavier residue is easily altered in density by rediffusion, and this would imply that it consists of a small quantity of a heavy gas mixed with a large quantity of the light gas. Repeated rediffusion convinced us that there was only a very small amount of the heavy gas present in the mixture. The portion which contained the largest amount of heavy gas was found to have the density 2·275, and its refractive index was found to be 0·1333. On rediffusing this portion of gas until only a trace sufficient to fill a Plücker's tube was left, and then examining the spectrum, no unknown lines could be detected, but, on interposing a jar and spark gap, the well known blue lines of argon became visible; and even without the jar the red lines of argon and the two green groups were distinctly visible. The amount of argon present, calculated from the density, was 1·64 per cent., and from the refractivity 1·14 per cent. The conclusion had therefore to be drawn that the heavy constituent of helium, as it comes off the minerals containing it, is nothing new, but, so far as can be made out, merely a small amount of argon.

If, then, there is a new gas in what is generally termed helium, it is mixed with argon, and it must be present in extremely minute traces. As neither helium nor argon has been induced to form compounds, there does not appear to be any method, other than diffusion, for isolating such a gas, if it exists, and that method has failed in our hands to give any evidence of the existence of such a gas. It by no means follows that the gas does not exist; the only conclusion to be drawn is that we have not yet stumbled on the material which contains it. In fact, the haystack is too large and the needle too inconspicuous. Reference to the periodic table will show that between the elements aluminum and indium there occurs gallium, a substance occurring only in the minutest amount on the earth's surface; and following silicon, and preceding tin, appears the element germanium, a body which has as yet been recognized only in one of the rarest of minerals, argyrodite. Now, the amount of helium in fergusonite, one of the minerals which yields it in reasonable quantity, is only 33 parts by weight in 100,000 of the mineral; and it is not improbable that some other mineral may contain the new gas in even more minute proportion. If, however, it is accompanied in its still undiscovered source by argon and helium, it will be a work of extreme difficulty to effect a separation from these gases.

In these remarks it has been assumed that the new gas will resemble argon and helium in being indifferent to the action of reagents, and in not forming compounds. This supposition is worth examining. In considering it, the analogy with other elements is all that we have to guide us.

We have already paid some attention to several triads of elements. We have seen that the differences in atomic weights between the elements fluorine and manganese, oxygen and chromium, nitrogen and vanadium, carbon and titanium, is in each case approximately the same as that between helium and argon, viz., 36. If elements further back in the periodic table be examined, it is to be noticed that the differences grow less, the smaller the atomic weights. Thus, between boron and scandium, the difference is 33; between beryllium (glucinum) and calcium, 31; and between lithium and potassium, 32. At the same time, we may remark that the elements grow liker each other the lower the atomic weights. Now, helium and argon are very like each other in physical properties. It may be fairly concluded, I think, that in so far they justify their position. Moreover, the pair of elements which show the smallest difference between their atomic weights is beryllium and calcium; there is a somewhat greater difference between lithium and potassium. And it is in accordance with this fragment of regularity that helium and argon show a greater difference. Then again sodium, the middle element of the lithium triad, is very similar in properties both to lithium and potassium; and we might, therefore, expect that the unknown element of the helium series should closely resemble both helium and argon.

Leaving now the consideration of the new element, let us turn our attention to the more general question of the atomic weight of argon, and its anomalous position in the periodic scheme of the elements. The apparent difficulty is this: The atomic weight of argon is 40; it has no power to form compounds, and thus possesses no valency; it must follow chlorine in the periodic table, and precede potassium; but its atomic weight is greater than that of potassium, whereas it is generally contended that the elements should follow each other in the order of their atomic weights. If this contention is correct, argon should have an atomic weight smaller than 40.

Let us examine this contention. Taking the first row of elements, we have:

$$\text{Li} = 7,\ \text{Be} = 9{\cdot}8,\ \text{B} = 11,\ \text{C} = 12,\ \text{N} = 14,$$
$$\text{O} = 16,\ \text{F} = 19,\ ? = 20.$$

The differences are:

$$2{\cdot}8,\ 1{\cdot}2,\ 1{\cdot}0,\ 2{\cdot}0,\ 2{\cdot}0,\ 3{\cdot}0,\ 1{\cdot}0.$$

It is obvious that they are irregular. The next row shows similar irregularities. Thus:

$$(? = 20),\ \text{Na} = 23,\ \text{Mg} = 24{\cdot}3,\ \text{Al} = 27,\ \text{Si} = 28,$$
$$\text{P} = 31,\ \text{S} = 32,\ \text{Cl} = 35{\cdot}5,\ \text{A} = 40.$$

And the differences:

$$3{\cdot}0,\ 1{\cdot}3,\ 2{\cdot}7,\ 1{\cdot}0,\ 3{\cdot}0,\ 1{\cdot}0,\ 3{\cdot}5,\ 4{\cdot}5.$$

The same irregularity might be illustrated by a consideration of each succeeding row. Between argon and the next in order, potassium, there is a difference of $-0{\cdot}9$; that is to say, argon has a higher atomic weight than potassium by 0·9 unit; whereas it might be expected to have a lower one, seeing that potassium follows argon in the table. Farther on in the table there is a similar discrepancy. The row is as follows:

$$\text{Ag} = 108,\ \text{Cd} = 112,\ \text{In} = 114,\ \text{Sn} = 119,$$
$$\text{Sb} = 120{\cdot}5,\ \text{Te} = 127{\cdot}7,\ \text{I} = 127.$$

The differences are:

$$4{\cdot}0,\ 2{\cdot}0,\ 5{\cdot}0,\ 1{\cdot}5,\ 7{\cdot}2,\ -0{\cdot}7.$$

Here again there is a negative difference between tellurium and iodine. And this apparent discrepancy has led to many and careful redeterminations of the atomic weight of tellurium. Prof. Brauner, indeed, has submitted tellurium to methodical fractionation, with no positive results. All the recent determinations of its atomic weight give practically the same number, 127·7.

Again, there have been almost innumerable attempts to reduce the differences between the atomic weights to regularity, by contriving some formula which will express the numbers which represent the atomic weights, with all their irregularities. Needless to say, such attempts have in no case been successful. Apparent success is always attained at the expense of accuracy, and the numbers reproduced are not those accepted as the true atomic weights. Such attempts, in my opinion, are futile. Still, the human mind does not rest contented in merely chronicling such an irregularity; it strives to understand why such an irregularity should exist. And, in connection with this, there are two matters which call for our consideration. These are: Does some circumstance modify these "combining proportions" which we term "atomic weights"? And is there any reason to suppose that we can modify them at our will? Are they true "constants of Nature," unchangeable, and once for all determined? Or are they constant merely so long as other circumstances, a change in which would modify them, remain unchanged?

In order to understand the real scope of such questions, it is necessary to consider the relation of the "atomic weights" to other magnitudes, and especially to the important quantity termed "energy."

It is known that energy manifests itself under different forms, and that one form of energy is quantitatively convertible into another form, without loss. It is also known that each form of energy is expressible as the product of two factors, one of which has been termed the "intensity factor," and the other the "capacity factor." Prof. Ostwald, in the last edition of his "Allgemeine Chemie," classifies some of these forms of energy as follows:

Kinetic energy is the product of mass into the square of velocity.

Linear energy is the product of length into force.

Surface energy is the product of surface into surface tension.

Volume energy is the product of volume into pressure.

Heat energy is the product of heat capacity (entropy) into temperature.

Electrical energy is the product of electric capacity into potential.

Chemical energy is the product of "atomic weight" into affinity.

In each statement of factors, the "capacity factor" is placed first and the "intensity factor" second.

In considering the "capacity factors," it is noticeable that they may be divided into two classes. The two first kinds of energy, kinetic and linear, are independent of the nature of the material which is subject to the energy. A mass of lead offers as much resistance to a given force, or, in other words, possesses as great inertia, as an equal mass of hydrogen. A mass of iridium, the densest solid, counterbalances an equal mass of lithium, the lightest known solid. On the other hand, surface energy deals with molecules, and not with masses. So does volume energy. The volume energy of two grammes of hydrogen, contained in a vessel of one liter capacity, is equal to that of thirty-two grammes of oxygen at the same temperature, and contained in a vessel of equal size. Equal masses of tin and lead have not equal capacity for heat; but 119 grammes of tin has the same capacity as 207 grammes of lead, that is, equal atomic masses have the same heat capacity. The quantity of electricity conveyed through an electrolyte under equal difference of potential is proportional, not to the mass of the dissolved body, but to its equivalent, that is, to some simple fraction of its atomic weight. And the capacity factor of chemical energy is the atomic weight of the substance subjected to the energy. We see, therefore, that while mass or inertia are important adjuncts of kinetic and linear energies, all other kinds of energy are connected with atomic weights, either directly or indirectly.

Such considerations draw attention to the fact that quantity of matter (assuming that there exists such a carrier of properties as we term "matter") need not necessarily be measured by its inertia, or by gravitational attraction. In fact, the word "mass" has two totally distinct significations. Because we adopt the convention to measure quantity of matter by its mass, the word "mass" has come to denote "quantity of matter." But it is open to anyone to measure a quantity of matter by any other of its energy factors. I may, if I choose, state that those quantities of matter which possess equal capacities for heat are equal; or that "equal numbers of atoms" represent equal quantities of matter. Indeed, we regard the value of material as due rather to what it can do, than to its mass; and we buy food, in the main, on an atomic, or perhaps, a molecular basis, according to its content of albumen. And most articles depend for their value on the amount of food required by the producer or the manufacturer.

The various forms of energy may therefore be classified as those which can be referred to an "atomic" factor and those which possess a "mass" factor. The former are in the majority. And the periodic law is the bridge between them; as yet, an imperfect connection. For the atomic factors, arranged in the order of their masses, display only a partial regularity. It is undoubtedly one of the main problems of physics and chemistry to solve this mystery. What the solution will be is beyond my power of prophecy; whether it is to be found in the influence of some circumstance on the atomic weights, hitherto regarded as among the most certain "constants of nature;" or whether it will turn out that mass and gravitational attraction are influenced by temperature, or by electrical charge, I cannot tell. But that some means will ultimately be found of reconciling these apparent discrepancies, I firmly believe. Such a reconciliation is necessary, whatever view be taken of the nature of the universe and of its mode of action; whatever units we may choose to regard as fundamental among those which lie at our disposal.

In this address I have endeavored to fulfill my promise to combine a little history, a little actuality and a little prophecy. The history belongs to the Old World. I have endeavored to share passing events with the New; and I will ask you to join with me in the hope that much of the prophecy may meet with its fulfillment on this side of the ocean.

ARE GENIUSES LONG LIVED?

No, says the popular verdict, based not unreasonably on the idea that the drain on the nervous forces which is attendant upon genius is not conducive to longevity. Yes, says a writer, David Lindsay, in the Gentleman's Magazine, basing his answer upon a long array of figures showing the age at death of a large number of the world's most illustrious sons, selected "with strict impartiality," which figures prove that nearly one-half of the greatest geniuses of the world have passed the Psalmist's limit of threescore years and ten. We give below his tables, which, it will be observed, include none of the gentler sex:

MILITARY MEN.

Name	Age at death	Name	Age at death
Xenophon	86	Charlemagne	71
Dumouriez	84	Timur	68
Wellington	83	Themistocles	65
Soult	82	Condé	65
Bernadotte	80	Dionysius the Elder	63
Muza Ibn Noseyr	77	Hannibal	63
Blücher	76	Turenne	62
Frederick the Great	74	Sulla	60
Agathocles	72	Massena	58
Genghis-Khan	72	Pyrrhus	50
Tilly	72	Napoleon	52
Marlborough	72	Alexander the Great	32
Marius	71		

STATESMEN.

Name	Age at death	Name	Age at death
Benjamin Franklin	84	Cicero	63
Talleyrand	84	William the Conqueror	60
Paoli	80	Louis the Eleventh	60
Palmerston	80	Cromwell	59
Lord Burleigh	77	Machiavelli	58
Augustus Cæsar	76	Richelieu	57
Cosmo del Medici	75	Fox	57
Disraeli	75	Julius Cæsar	55
Chatham	69	Alfred the Great	52
Edward the First	68	Pitt	47
Walpole	68	Mirabeau	42
Washington	67		

SCIENTISTS AND PHILOSOPHERS.

Name	Age at death	Name	Age at death
Humboldt	89	Linnæus	70
Carlyle	85	Leibnitz	70
Newton	84	Huxley	70
Herschel	84	Socrates	68
Plato	82	Arago	67
Buffon	80	Aristotle	62
Kant	79	Cuvier	63
Galileo	78	Hegel	61
Locke	72	Tycho Brahé	55
Epicurus	71	Descartes	53
Copernicus	70	Spinoza	44

LITERARY MEN.

Name	Age at death	Name	Age at death
Sophocles	90	Cervantes	68
Izaak Walton	90	Dryden	68
Voltaire	84	Milton	65
Goethe	83	Sir Walter Scott	61
Victor Hugo	83	Bunyan	60
Hallam	81	Racine	59
Livy	80	Macaulay	59
Corneille	78	Horace	57
Herodotus	76	Dickens	57
Samuel Johnson	75	Dante	56
Euripides	74	Pope	56
Froissart	73	Gibbon	56
Chaucer	72	Shakespeare	52
Thucydides	70	Virgil	51
Petrarch	70	Molière	51
Defoe	70	Schiller	45
Rabelais	70	Burns	37
Wordsworth	77	Byron	36
Æschylus	69	Shelley	30

MUSICIANS

Name	Age at death	Name	Age at death
Haydn	77	Schumann	46
Händel	75	Weber	39
Spohr	75	Chopin	39
Palestrina	70	Mendelssohn	38
Bach	65	Mozart	35
Beethoven	56	Schubert	25

PAINTERS.

Name	Age at death	Name	Age at death
Titian	99	Rembrandt	63
Michael-angelo	89	Velasquez	61
Turner	76	Holbein	57
Reynolds	68	Vandyck	42
Hogarth	67	Correggio	40
Rubens	63	Raphael	37

REFORMERS.

Name	Age at death	Name	Age at death
Wesley	87	Knox	67
Swedenborg	84	Mahomet	62
Brigham Young	76	Luther	66
Confucius	72	Calvin	54
Erasmus	68	Savonarola	46

INVENTORS AND DISCOVERERS.

Name	Age at death	Name	Age at death
William Harvey	79	George Stephenson	67
Réaumur	74	Arkwright	60
Jenner	74	Robert Fulton	50

Mr. Lindsay makes the following summary of the tables:

At an age of above 80, 17 per cent. died,
" " 70 to 80, 28 " "
" " 60 to 70, 25 " "
" " 50 to 60, 17 " "
" " under 50, 13 " "

While, therefore, nearly one-half of those whose names appear in the foregoing lists passed the age of seventy, most of their best work, Mr. Lindsay goes on to remark, appeared at a comparatively youthful age. He continues:

"What, then, are the laws that control the age of genius? Why should a Keats die at twenty-four and a Chaucer at seventy-two? Why should philosophers and men who look deeply into the heart of things, and who would naturally be supposed to wear out their vital energy more quickly than other men—why should these be longer lived than musicians?

"To this latter question there is an answer. It is not until after long years of technical training and brain working that such men as Leibnitz and Descartes

blossom out into all their glory of genius; and there are doubtless many great thinkers even now in our midst who may some day astonish the world by the brilliancy of their teachings—but they may first die. With music it is different. Beethoven, while yet in his early infancy, showed unmistakable signs of his natural abilities; when he was a mere youngster he composed works which, to this day, will stand on their own merits. It is the same with every great musician. Granted that he live to reach early manhood, his fame is secured. And at the time when all Europe is ringing with his praises, his science-loving brother is toiling in obscurity, not to step forth into the light of popularity for maybe another quarter of a century, or perhaps not at all, for in the meantime, as we have said, he may die.

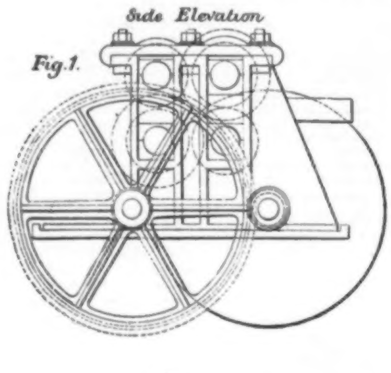
"It is true that the very greatest masters of all do not usually live out their normal length of days: Napoleon, Cromwell, Shakespeare, Beethoven—none of these passed into old age. But it is hard to define the term 'genius.' If we are to limit it to some score of men, we must then, perhaps, consider that it is incompatible with length of life. If we give the word larger meaning, and honor with it the thousand lesser lights who illumine the page of history, why, then, it would seem to be a healthy thing to be a genius."

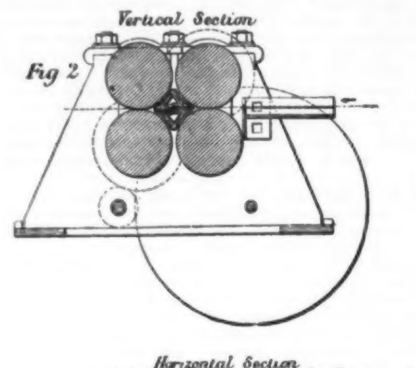
Cleaning Beer Pipes.—In cleaning pipes through which beer is run the following precautions should be observed in order that the soda solution used may have its disinfectant effect. The solution should contain 5 to 10 per cent. of soda. It should be in contact with the pipes no less than one-half hour, and the temperature must not be allowed to fall below 80 deg. Centigrade (212 deg. Fah.) The disinfecting action of soda is not very strong. The main value of the process lies in the power soda has of dissolving off the impurities, and so preparing the pipes for further disinfection by steam.—Uhland's Wochenschrift.

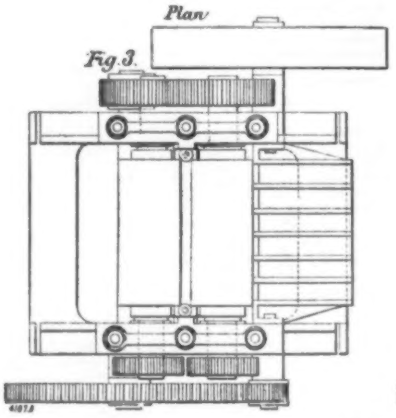
THE MANUFACTURE OF TIN PLATES.*

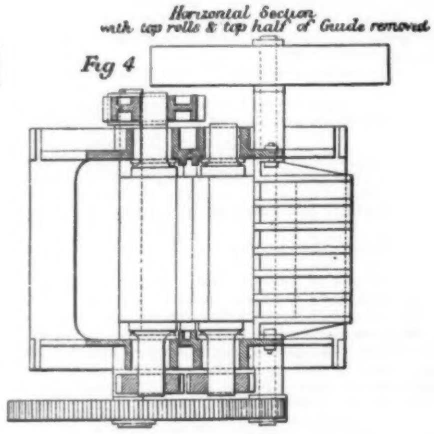
By George B. Hammond, Penarth.

In accepting the invitation of your council to prepare a paper on the manufacture of tin plates, I am keenly alive to the difficulty of doing justice to a subject which has been so ably dealt with in the interesting papers read before the institute by Mr. Ernest Trubshaw and by the late Mr. P. W. Flower. I venture, however, to undertake the task, as considerable progress has been made in the science and practical mode of manufacture during recent years, and, however unworthy my paper may be in itself, the subject has an important bearing on the steel trade of the country, and claims more than ordinary interest for this district in which you are now meeting, as the neighboring town of Pontypool was the birthplace of the British tin plate trade, about the year 1665, when, under the auspices of the Hanbury family, Mr. Andrew Yarranton made an attempt to establish the manufacture there, on knowledge obtained by him in Saxony, where the trade was at that time in a flourishing condition. Mr. Yarranton's undertaking produced but little results at the time. Other active minds were, however, apparently engaged in the same direction, for it is recorded that one William Chamberlaine took out a patent in the year 1673 for "a newe arte, mistery, or invencon of great use, etc., for plateing and tynning of iron, copper, steele, and brasse, as also for compressing and plateing of all other metalls," which invention related to the use of certain "engines or instruments and wayes and meanes" of tinning and plating iron, etc.; and seventeen years later, in 1691, John Hemingway was granted a patent, owing to influence at the Court of William and Mary, for the sole use for fourteen years of an invention for "makeing of iron plates tynned over, commonly called tynned plates."









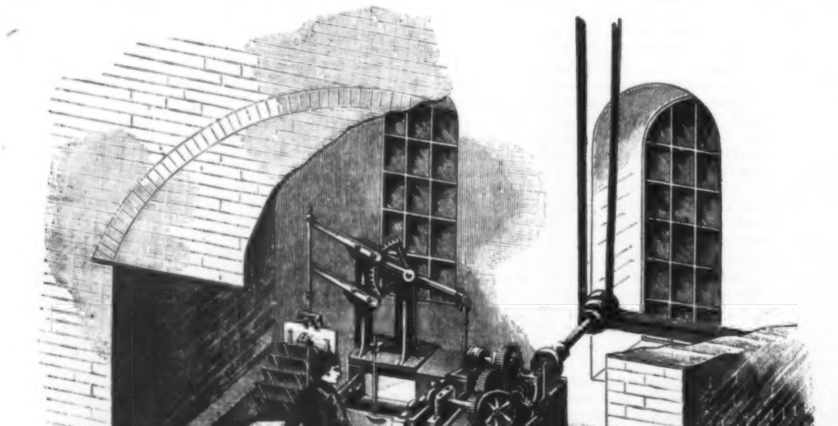


Fig. 8.

THE MANUFACTURE OF TIN PLATES.

This latter patent, though never actively used, was the cause of the industry being abandoned for a time at Pontypool, until, in the year 1720, Major John Hanbury restarted the Pontypool works; but his venture was attended with little success for some years. The method of producing was slow and laborious, the operation being that of flattening out hot slabs of iron under a quick action helve or tilt hammer, the pieces as reduced in thickness being doubled over and piled with other pieces reduced in the same way, the surfaces being sprinkled with powdered coal or charcoal to prevent welding, the hammering being continued until the required size and thickness were obtained. The plates were afterward steeped in a weak solution of sour rye water or vinegar for several days to remove the oxide and other injurious substances formed on the surface of the plates during the operation of forging, and when cleaned, were immersed in a bath of molten tin.

In the year 1728, Major Hanbury and John Payne brought out an invention for rolling sheet iron, and it was found that plates produced by this new method possessed a finer surface, were more uniform in thickness, softer and more pliable in working, and were much esteemed by the consumers of the time.

The trade then spread to some of the neighboring works of Monmouthshire and Glamorganshire, and in some few instances to the other ironmaking districts. The development was gradual, and the production was soon sufficient for the requirements of this country, and the imports from the Continental works ceased. It was not, however, till the present century that the trade made any rapid strides, when, by the advance of science and civilization, the uses to which tin plates may be applied in the canning of fish, fruit, other food stuffs, and oil became known.

The trade, however, gave constantly increasing employment to the laboring classes of South Wales and Monmouthshire, a district which has retained its position as the principal seat of the manufacture for more than 150 years, extending to the present time. Whole families have engaged in the industry in the same localities from generation to generation, until their present representatives, with some reason, look upon the trade as their birthright, and regard with jealous eyes the now rapid growth of the manufacture in other countries, preferring, in times of depression, to follow the trade into distant lands rather than engage in other occupations at home. It is also a noteworthy fact that wherever tin plate works have been established within recent years, Welsh workers have been required to instruct the native labor and to assist in the development of the art. At the present time employment is found in this country for many thousands of workpeople in the industry itself, and many thousands more in those trades which are dependent on providing the materials from which tin plates are produced; one instance of which is the fact that more than half a million tons of British steel bars are annually produced for the purpose, some of our largest steel works being partially, and in some instances wholly, employed in manufacturing this material. The expansion of the trade in this country over the last thirty years has been very marked, and the extent of it may be gathered from the following statistics, taken from the Board of Trade returns, representing the shipments to all countries of the world, and taken at intervals over the period named, but they do not include the plates produced for home consumption, nor—as regards the periods to 1895—the black plate shipped for coating abroad:

Year.	Weight.	Value.	Average Price.
	Tons	£	£
1867	78,906	2,060,410	26·11
1872	118,083	3,806,973	32·24
1877	153,226	3,033,126	19·80
1882	265,039	4,642,125	17·51
1887	353,506	4,792,854	13·56
1891	448,379	7,166,655	15·98
1892	395,449	5,330,216	13·48
1893	379,172	4,991,300	13·16
1894	353,928	4,338,786	12·26
1895	366,120	4,239,193	11·58
	Blackplate 34,368	338,346	
1896	266,963	3,036,015	11·37
	Blackplate 48,405	477,999	

It is interesting to note in the above figures the gradually declining values of the material, and it is doubtless this which has in the past given the stimulus to the trade, and has largely added to the uses for which the material has been adapted. The largest exports were in 1891, and until that year the industry had been almost entirely confined to this country, and the American market was supplied entirely from Wales; but with the introduction of the McKinley tariff, which increased the import duty to 2·23 cents per pound (equivalent to 10s. per cwt.), works were established in the United States, and these have since been operated with considerable success. The growth of the industry there has been very rapid, the estimated output for the years ending June 30, 1892 to 1896, being as follows:

	Tons.
1892	5,803
1893	44,196
1894	62,053
1895	86,160
1896	137,053

In a report lately prepared for the British Foreign Office, it is stated that there are now 180 mills in existence in the United States, 170 of which are working, 11 new ones are in process of construction, with a total potential capacity of 6,250,000 boxes, about equal to the total American consumption in 1896, and the present production is stated to be variously estimated at from 4,000,000 to 5,000,000 boxes a year.

The imports of British tin and terne plates into the United States have rapidly declined in these years, thus:

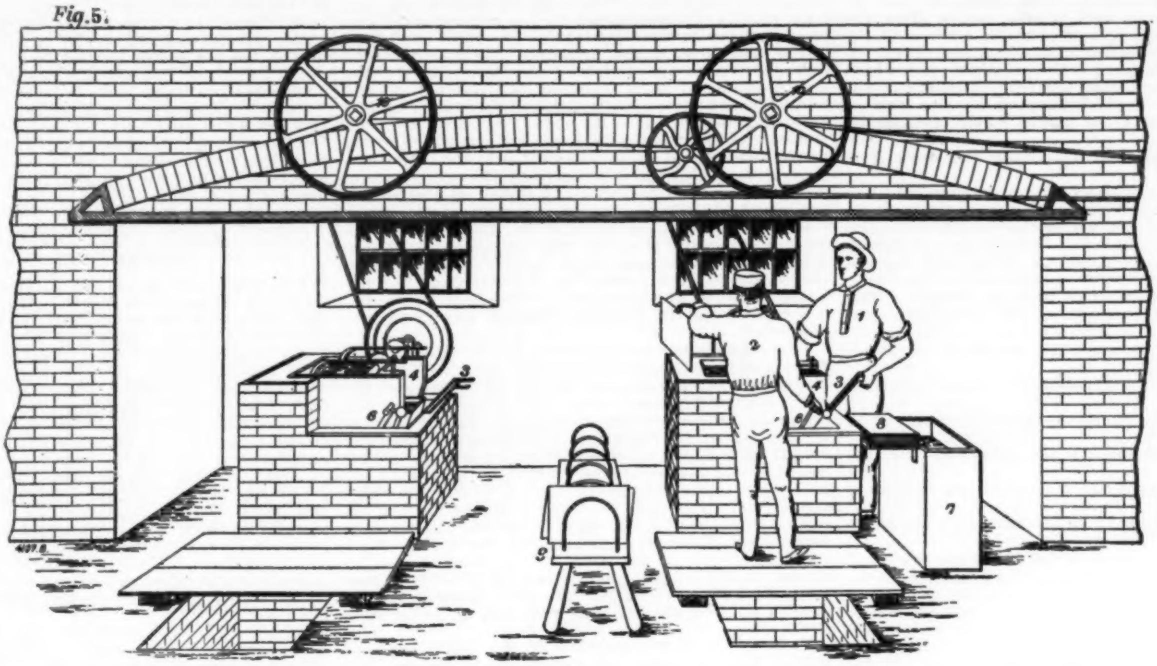
	Tons.
1891	325,143
1893	280,546
1894	226,880
1895	223,077
1896	113,049

* Paper read before the Iron and Steel Institute.

France, Germany, Italy, Spain, and Austria are also producing, and the Welsh makers are anxiously seeking markets abroad. In the meanwhile great depression exists. Of the 490 mills in Great Britain at the present time, only 302 were in operation at the end of April.

During the last fifteen years a great revolution has taken place in the trade by the general adoption of mild steel as a substitute for iron bars, which were formerly produced in the charcoal and puddling forges attached to the tin plate works of the district, with the result that these forges have been entirely abandoned and the tin plate trade proper may now be considered to commence with the rolling of the steel bar into blackplate, although some of the larger works have erected open hearth steel plants. It is my intention, however, to deal with the manufacture commencing with the steel bars.

Fig. 5.



For this purpose mills are employed, consisting of two pairs of rolls, the first pair for breaking or roughing down the steel bar into plate form, and the second for finishing the plates.

Two heating furnaces and two pairs of shears, to one of which is attached a doubling table and squeezer for doubling and flattening the sheets after elongation between the rolls. The rolls are made of a mixture of strong, tough, cold blast iron, cast in chills. Before being put to work, the necks and bodies are turned in a lathe. After being put in position in the mills the bodies are again dressed and fitted to each other, to work evenly together when expanded at their work.

I may here mention that the general practice in the United States varies by employing one pair of rolls only in a mill, the operation of roughing down and finishing being performed in the same pair, or in some cases three pairs of rolls are employed for two mills, one pair doing the roughing down for the two finishing.

The furnaces are of the reverberatory type, and the bars and sheets charged on the bed of the furnace are acted on by the flame from the grate placed at the back. Defects or wasters are sometimes produced by particles of small coal and ash being carried forward from the grate or picked up from the bed of the furnace, and subsequently rolled into the surface of the sheets. In some modern works, gas producers are employed for supplying the furnaces with fuel, and beneficial results are obtained as regards quality of plates produced and the decrease of wasters.

The workmen employed in the mills are formed in sets, consisting of a roller, doubler, furnaceman, and catcher—the roller being the head, and having charge of the mill. Three sets are employed for eight hours each in a day of twenty-four hours for five days in the week, and one set on the Saturday; the mills run continuously from Monday morning till midday on Saturday. A shearer and three openers generally cut and open the work from each mill.

The operation is as follows: The rough bars from the steel works, of suitable gage, varying from ¼ inch to ¾ inch thick and 7 inches to 10 inches in width, are cut into short lengths corresponding with the width of the plate to be produced, and are placed in the first or thick iron furnace, and when heated to redness are delivered to the roller, who passes each piece several times between the roughing rolls; the catcher, stationed behind the rolls, catches the pieces as they pass through, and returns them over the top roll. When sufficiently extended, the pieces are replaced in the same furnace, and heat equivalent to that lost in the operation of rolling is restored. When they are again extended by rolling, the doubler doubles the two ends of each piece together, flattening the piece under the squeezer, by which it should be observed the substance for resistance in the next operation of rolling is not diminished. In this stage the pieces are known as "doubles." The doubles are now charged into the second or finishing furnace, leaving the thick iron furnace free to heat another charge of rough bars while the operation of finishing the former is continued. When the "doubles" are heated the pieces are again extended, the second doubling is performed, and the uneven ends are cut off at the shears; "fours" being thus produced. The packs are again subjected to the action of the finishing furnace and prepared for final rolling, or the process is continued after further rolling and doubling to "eights," as may be necessary for the gage required. It is customary in every instance after two or more thicknesses of doubled plates have been rolled together to separate them before reheating, care being taken to replace the pieces in position in the pack; this avoids welding of the surfaces, and facilitates the final separation or opening of the finished sheets. It is known that each piece of rough bar of given weight, if carefully manipulated, will produce so many sheets of the desired size and gage, and considerable skill is required to obtain sufficient length and, at the same time, to avoid exceeding it, or the steel would cut to waste. When the roller is satisfied that he has obtained the above requirements, the pieces are placed on trolleys for conveyance to the finishing shears, and when cool are cut by the shearer into the sizes of the order in hand.

The next process is that of opening or separating the plates pressed together by the final rolling; for this girls are employed, who do the work by hand, separating sheet from sheet with much dexterity. In this state the plates are known as rough blackplate. A machine, for which a big future seems possible, has lately been invented by Messrs. Williams & White, for opening or separating blackplate or sheets, and the following description may be found of interest:

The machine consists essentially of two pairs of rolls, all driven at the same circumferential speed, and placed with their axes all parallel to each other. Between the first and second pair of rolls is placed a "waved guide," consisting of hard, smooth, chilled iron plates. These plates are firmly held at a proper distance from each other, and the "guide" formed by the two plates is firmly held in position between the two pairs of rolls, as shown in Figs. 1, 2, 3 and 4.

The action of the machine is as follows: The packs of unopened blackplate to be opened by the machine are passed through the first pair of rolls. From these they pass through the sinuous passage of the guide plates. After leaving the last bend or curve in the guide, the second pair of rolls seizes the plates and draws the packs through, completing the operation. After leaving the second pair of rolls the packs fall on a trolley, where they accumulate until wheeled away for the next process.

It may be explained that the individual sheets comprising the pack are held together by very thin films of oxide of iron, which forms on the surface during the working of the sheets while hot.

As the packs are forced around the curves of the

Fig 6 Section A.B

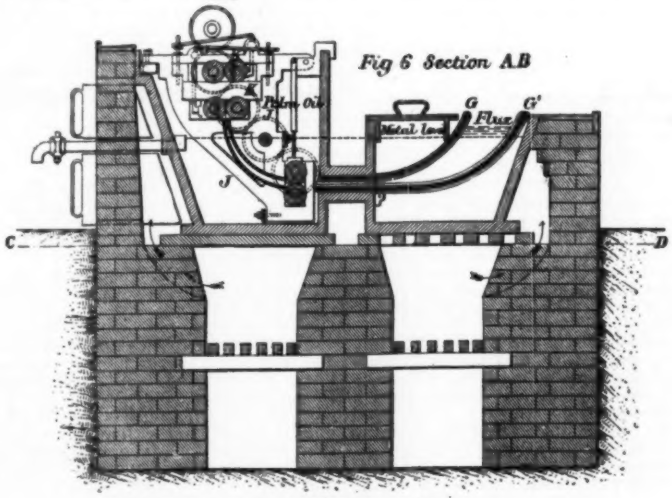
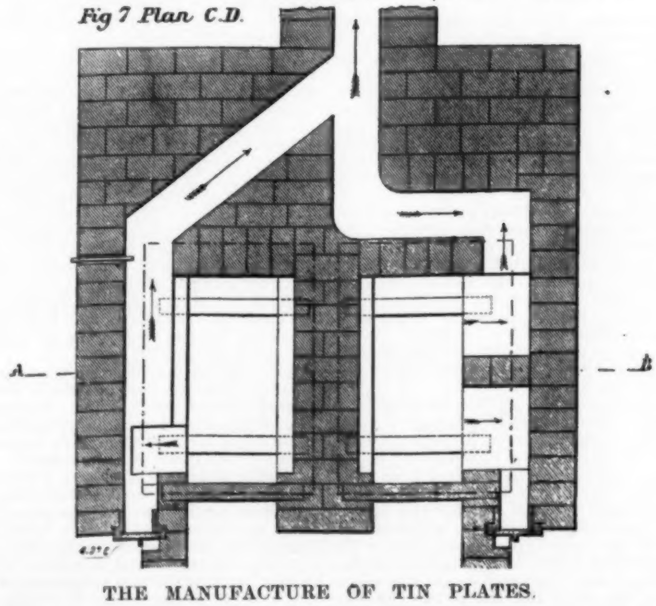


Fig 7 Plan C.D.



THE MANUFACTURE OF TIN PLATES.

waved passage, the sheets of metal and the films of iron oxide are bent to and fro. This bending to and fro is harmless as far as the metal is concerned, but it is destructive to the films of oxide; hence the cementing medium is destroyed and the sheets are separated. The separation is further assisted by the varying velocities of the individual sheets in passing around the curves of the guides. For example, the sheet next the convex face of the guide travels slower than the sheet next the concave face. This sliding is seen by simply rolling a book with pliable covers, when the leaves step back from each other at the edges and the faces all slide on each other.

This sliding and bending is the principle upon which the machine is constructed, and the principle is the same as that of the method adopted by the girls of bending the corners of the packs when opening by hand.

One machine is capable of opening the work from four or five mills.

The average capacity of an efficient modern tin plate mill is forty to fifty boxes (of 1 cwt. each) in eight hours; but until recently, under their union rules, the workpeople have been restricted to an output of thirty-six boxes; this cannot, however, be upheld, as the only hope for this country to retain a hold on the trade is to obtain big makes and to produce cheaply. The wages paid in the mills known as the "1874 List" are as follows:

Roller, 3s. 5d. per dozen boxes = average of 10s. to 13s. per turn.

Doubler, 2s. 9d. per dozen boxes = average of 8s. to 10s. per turn.

Furnacemen, 2s. 7d. per dozen boxes = average of 7s. 6d. to 9s. 9d. per turn.

Catcher, 1s. 3d. per dozen boxes = average of 3s. 9d. to 4s. 9d. per turn.

Shearing, 1s. 1d. per dozen boxes =average of 10s. to 12s. per turn.

Openers, 6s. 3d. per 100 boxes = average of 2s. 3d. to 2s. 9d. per turn.

Black Pickling.—This operation is necessary to clean the oxide of iron formed by the action of the air on the heated surface of the plates in the mills, and is now universally done by means of machines provided with cradles, in which the plates are packed on their edges in bulk, for immersion first in diluted sulphuric or hydrochloric acid to remove the scaly oxide, and afterward in water to wash off all traces of acid; a quick, vertical, horizontal or rocking motion being conveyed to the cradles to permit the liquid to circulate through and pass between the plates under treatment. The machines most in use are those made by Mr. David Grey, of Maesteg, by the Millbrook Company, of Swansea, and by Messrs. Taylor & Sturve, of Briton Ferry, the essential difference in them being the modes by which the cradles are conveyed to and from the acid and water tanks, and by which the motion is applied to the cradles in the liquids.

Great economies have been effected in labor and in the quantities of acid required by these mechanical appliances over the old fashioned hand pickling in leaden vats, the tedious process that was employed twenty years ago.

Black or First Annealing.—The plates after leaving the pickling machines are packed in piles on iron stands and are covered over with inverted iron or steel boxes, called pots, sand being used around the mouth to exclude the air. The boxes with inclosed plates are then subjected to a mild flame in a large reverberatory furnace for eight to ten hours and are then allowed to cool gradually, the object being to soften the plates that they may be more easily polished in the preparation for tinning.

Cold Rolling.—This process consists of passing the plates one by one when cold three or four times between highly polished chilled rolls working under great pressure, and is necessary to remove any buckle or unevenness from the plate and to produce a flat, bright, polished surface for receiving the coating of tin. The plates are hardened by this process, and it is necessary to give them a second or white annealing, the plates being treated in the closed pots as before, but subjected to a milder heat. On cooling they are again soft, with a bright appearance, and are in this state called finished blackplate. A second or white pickling is necessary to remove any oxide formed in the annealing processes. This process is performed in the same way as the first pickling, but the acid solution is weaker, and, after the plates are removed from the swilling tanks, they are kept in water until taken to the tin pot.

Tinning.—In former times this process was performed by soaking the plates in the molten metal and afterward arranging them on edge in a rack fixed in the grease pot to allow the surplus tin to drain off them, the thickness of the coating being determined to some extent by the length of time the plates remained in the hot grease. The process was very wasteful, and it was impossible by its means to obtain a uniform coating over the surface of the plates. About the year 1860 Mr. Edmund Morewood, of Llanelly, and Mr. John Saunders, of Corkley, invented machines with rolls placed in the grease pot to better regulate the quantity of metal, whereby an immense saving was obtained and a superior and more evenly coated plate was produced. This method, with modifications in detail, continues to the present day.

In the process as introduced by Mr. Morewood, the wet plates from the swilling troughs of the white pickling machine were immersed sheet by sheet by the tinman, twenty-five to thirty at a time, in a bath of melted palm oil to absorb the moisture on the surface of the plates and then removed and dipped into a series of pots containing molten tin at various temperatures; and, after being brushed one at a time on both surfaces by the washman with a hempen brush, they were conveyed by him to the grease pot in which the rolls revolved. The plates, on issuing from the rolls in a vertical direction, were raised by a boy and placed in a rack, from which girls removed them to dip in iron for the purpose of removing grease adhering to the surface. They were afterward polished by slightly rubbing with a duster of sheepskin or other soft material, by which the coating operation was completed.

The capacity of modern machines employed in the above method varies from thirty to forty boxes in proportion to the number of rolls working in the grease pot and the class of work in hand. The wages paid under the 1874 list are:

Tinman, 3d. per box = 7s. 6d. to 10s. per day.

Washman, 3d. per box = 7s. 6d. to 10s. per day.

Grease boy, 1d. per box = 2s. 6d. to 3s. 4d. per day.

Dippers, girls (usually two), 7s. per 100 boxes = 2s. to 2s. 9d. each per day.

Dusting, 6d. per 100 boxes = 1s. 9d. to 2s. 4d. per day.

For years past attempts have been made to economize on this method and to employ chloride of zinc as a tinning flux in substitution for palm oil in the first pot, but the results for some time were not satisfactory, and large parcels of plates coated by the experimental processes arrived at their destination in a rusty condition, owing, doubtless, to the presence of free acid in the flux and the porous nature of the iron coated; the workmen also strongly opposed the innovation, and found means to prejudice buyers and consumers against accepting delivery of any plates prepared by such methods as injurious to the food products which would be packed in them; and it was not until steel came into general use, assisted, doubtless, by the more careful preparation of the flux, that any degree of success was attained in this direction.

It is now in general use, and by its means the operation of coating is much more rapidly effected and a brighter finished plate is produced; it has also been proved beyond the possibility of doubt that the material so used is innocuous to the fish, fruit and other goods for the packing of which the plates are employed.

From this change may be dated the successful introduction of mechanical tinning pots, by which further savings are effected in material and the services of the washman are dispensed with. These mechanical tinning pots, now known in the trade as "patents," are of various makes, the variations consisting principally in detail, each maker claiming some advantage for his machine over that of others. They may, however, be divided into two classes, in one of which the plates travel vertically and in the other in a half circular direction from the flux, through the tin and into the rolls revolving in the grease box end. Of the former type, those of Messrs. Thomas, of Melingriffith, Daniel Edwards, of Morriston, and Thomas & White, of Llangennech, and of the latter, those of Messrs. Taylor, Struve & Company, of Briton Ferry, and Player, of Clydach, are well known machines.

Fig. 5 represents a machine of the vertical type at work. This machine, patented in 1882 by Messrs. Taylor & Leyshon, and made by Messrs. Taylor, Struve & Company, of Briton Ferry, was the first single pot for coating and finishing without the aid of the washman to meet with practical success, and is still in use at many of the most important works to the present time, with very slight alteration in detail. The principle employed being that of drawing or pulling the plates, by means of a nipping appliance working beneath the surface of the metal, through the flux into the tin in a vertical direction, so as to allow the plate to clear itself of any scruff adhering to it. The plates enter and leave the pot perfectly flat, and a coating of any quality may be produced, this being regulated by the speed of the rolls in the grease box and by the quantity of tin in the troughs under the finishing rolls, which also tends to wash off any scruff taken up in the tin pot. The machine is simple in construction and is made of various dimensions to suit the sizes of plates to be dealt with. It is specially adapted also for thin plates or taggers, the thinnest of which can be coated by it.

Figs. 6 and 7 illustrate one of the "half circular" machines. The molten tin occupies the space in the lower part of the pot, the flux lying on the surface of the tin at the feeding end, where it may be confined in position by means of a rectangular box (constructed with four sides and without ends) inserted partly below the surface of the metal. The palm oil also lies on the surface of the tin, but at the delivery end, and is confined by the grease box.

The plate is inserted by the tinman between the iron bars which form the guide, G G′, and passes through the flux into the molten metal and is moved onward by a light iron rod in the hand of the tinman until it reaches the revolving rolls, H, by which it is conveyed forward through the guides, J J′, out of the tin and into the finishing rolls, K K′, revolving in the grease. The plate issuing from the rolls in a coated state is placed by the grease boy in a rack for removal by the dipper.

Two grates are provided, that the temperature at each end of the pot may be separately controlled, a higher degree of heat being necessary at the feeding end than is desirable at the delivery or finishing end; this is further assisted by the narrow passage or neck which forms the connection between and keeps apart the two layer bodies of the metal. Plates of any length can be coated in this pot; the makers inform me they have satisfactorily coated experimentally one continuous length of plate 6 inches in width and 150 feet long.

Some of the half circular machines are constructed with two distinct chambers. By this method the plate, after passing in a half circular direction through the first bath of tin, is conducted by means of rolls over the top of the division into the second bath of metal, above the surface of which the finishing rolls are placed in the grease, the temperature of the separate baths being controlled by a fire for each.

The method of working is substantially the same in nearly all the machines, a tinman and a boy being employed to do all the work.

Fig. 8 illustrates another machine of the vertical type at work. This machine, the invention of Messrs. Rogers & Player, is unique in its operation, as dispensing with the services of the grease boy—a tinman only being employed. The machine is of the vertical type and consists of one tin pot, with a grease pot over it, with one fire for the former and a small one for the latter, by which the necessary temperatures are maintained. The finishing rolls of this grease pot are provided with troughs containing molten metal, in which the rolls revolve with the object of washing or cleaning the plate of any scruff taken up from the tin pots. As the plates issue from the finishing rolls in the ordinary way they are automatically seized and removed to the rack to be dealt with by the dipper. This machine is known in the trade as the "iron man." The amount of tin required for coating by hand or by mechanical appliances is not material. A box of C 14 × 20 containing 112 sheets, and with a surface area of 435·5 square feet, may be coated with a good common coke finish with about two pounds of tin, a heavier coating being applied for a charcoal finish. By means of the mechanical pots, a saving is effected in the quantity of palm oil used; hemp for brushes is entirely dispensed with and a brighter plate is produced.

Dipping and Cleaning.—The plates, on issuing from the grease pots, are either dipped by hand in fine bran, meal or shudes in two operations (each surface having to be treated), or are mechanically conveyed through the material placed in two troughs in such a way that both sides of the plates may be acted upon. When any grease which remained on the surface has thus been removed, the plates are rubbed by hand, as previously described, or are passed through a nest of rolls covered with soft sheep skins, which revolve at circumferential velocities varying to each other, by which the necessary rubbing is obtained and the dust from the bran trough is removed. The operation being now complete, the plates are sorted, counted, weighed and boxed ready for dispatch from the works.—Engineering

JOHN CABOT AND THE DISCOVERY OF NEWFOUNDLAND.*

THE word America has become so completely grafted on to our cosmopolitan speech that we do not, as a rule, stay to consider the rationale of the appellation. It is true that Amerigo Vespucci, a Florentine, was one of the several explorers of the great land now from his name called America. But he was only a follower of another explorer, better known and deservedly honored, Christopher Columbus, after whom a republic, Colombia, has been called. We know that Columbus landed on one of the Bahama Islands—Guanahani or San Salvador, close to the tropic of Cancer—on October 12, 1492. But this was the first voyage of Columbus. He made other voyages, successively discovering new lands. Yet we Englishmen, a nation of great explorers, navigators and seafaring men, appear altogether to have forgotten that it is to the praise of our own King Henry VII that a northern portion of America, over sixteen hundred miles from San Salvador, was discovered, and before that portion was known to Columbus.

John Cabot, a Genoese pilot, but who had been naturalized as a Venetian, came to England and settled at Bristol with his wife and family in the reign of King Henry VII. Cabot, or Cabotta, or Kabotto, as his name is variously spelt, appears in a record in the archives of Venice, under the date March 28, 1476, as having been naturalized there after the usual residence of fifteen years. He had studied cosmography and navigation, and, for those days, had been a great traveler. He had visited Arabia, and seen at Mecca caravans which came from the East bringing vast quantities of spices. He had been told by the merchants who had care of the caravans that the spices brought by them were received by them from other merchants, who in their turn had received them from the remotest countries of the East. He fully believed in the new views which had influenced Columbus as to the roundness of the earth, and was of opinion that by sailing westward he might reach the land whence the spices came.

Details of what occurred are meager; but sufficient evidence is extant to understand some of the main features of the adventure.

Cabot applied for assistance to King Henry VII, who appears to have entered very fully into his plans, as we gather from the letters patent granted by that monarch on March 5 in the eleventh year of his reign (i. e., 1496). They are as follows:

"We have given and conceded, and by these presents do give and concede for us and our heirs to our well-beloved John Cabottus, citizen of Venice, and to Ludovicus, Sebastianus and Sanctus, sons of the said John, and to the heirs and assigns of them and each of them, and their deputies, full and free authority, faculty and power of navigating to all parts, countries and seas of the east, west and north, under our banners, flags and ensigns, with five ships or vessels of what burden or quality soever, and with as many mariners or men as they will have with them in the said ships, upon their own proper costs and charges, to seek out, discover and find whatsoever islands, countries, regions or provinces, of heathens or infidels in whatever part of the world they be which before this time were unknown to all Christians."

The letters patent then proceed to license John and his sons "to fly our banners" on the new lands, and grant the right to John and his sons to possess those lands "as our vassals," they "acquiring for us the dominion, title and jurisdiction of the same." They are to be subject to the obligation "to deduct for our use" a fifth part of the whole capital cargo of every voyage on its arrival at the port of Bristol; they are to return to the port of Bristol only; they are to be free from all customs duties. All mainlands, islands, cities, towns, camps and other places by them discovered "shall not be visited by other our subjects" without the license of John and his sons, their heirs and assigns, or their deputies, on pain of the forfeiting "by such other our subjects" of their vessels and goods. Lastly, these letters direct and command "all other our loving subjects, as well by land as by sea," to be helping and assisting the said John and his sons.

Cabot accordingly set sail in a small ship called the Matthew from the port of Bristol accompanied by two or three other small ships. Hakluyt (Voyages) says that he has copied the following from Fabian's Chronicle, but it is not to be found in any extant copy of that work. The extract is as follows:

"In the 13th year of Henry VII (1497), this year the king, by means of a Venetian, who was very expert and cunning in the knowledge of the circuit of the world and islands of the same, as by a card and other demonstrations he showed himself, caused to man and victual a ship at Bristol to search for an island which he said he knew; divers merchants of London ventured in her small stocks. The Venetian was chief patron, and in the company of the said ship sailed also out of Bristol three or four small ships freighted with merchandise, coarse cloth, caps, laces, and so departed from Bristol in the beginning of May."

It is most unfortunate that no log or account written by Cabot himself has come down to us. Even his map

* Nautical Magazine.

and globe have been lost or perished; we are, therefore, obliged to content ourselves with the testimony of contemporaries. Perhaps the most interesting and fullest account is that written by the Abbé Raimondo de Soncino, envoy of the Duke of Milan at the court of Henry VII, which is so valuable but so little known that we shall transcribe it at length. The Abbé writes* from London under date December 18, 1497, to the Duke, as follows:

"Most Illustrious and Excellent My Lord: Perhaps, among your excellency's many occupations, it may not displease you to learn how his majesty here has won a part of Asia without a stroke of the sword. There is in this kingdom a Venetian fellow—Master John Cabotta by name—of a fine mind, greatly skilled in navigation, who seeing that those most serene kings, first he of Portugal, and then the one of Spain, have occupied unknown islands, determined to make a like acquisition for his majesty aforesaid. And having obtained royal grants that he should have the usufruct of all that he should discover, provided that the ownership of the same be reserved to the crown, with a small ship and eighteen persons he committed himself to fortune; and having set out from Bristol, a western port of this kingdom, and passed the western limits of Hibernia (Ireland), and then standing to the northward he began to steer eastward, leaving (after a few days) the north star on his right hand; and having wandered about considerably, at last he fell in with terra firma, where, having planted the royal banner and taken possession on behalf of this king and taken certain tokens, he returned thence. The said Master John, being foreign born and poor, would not be believed, if his comrades, who are almost all Englishmen and from Bristol, did not testify that what he says is true. This Master John has the description of the world in a chart and also in a solid globe which he has made, and he shows where he landed, and that going toward the east he passed considerably beyond the country of the Tanais.† And they say that it is a very good and temperate country, and they think that Brazil wood and silks grow there, and they affirm that that sea is covered with fishes, which are caught not only with the net, but with baskets, a stone being tied to them in order that the baskets may sink in the water. And this I heard the said Master John relate, and the aforesaid Englishmen, his comrades, say that they will bring so many fishes that this kingdom will no longer have need of Iceland, from which country there comes a very great store of fish which we call stock fish. But Master John has set his mind on something greater, for he expects to go further on toward the east (Levant), from that place already occupied, constantly hugging the shore until he shall be over against an island by him called Cipango,‡ situated in the equinoctial region, where he thinks all the spices of the world and also the precious stones originate; and he says that in former times he was at Mecca, whither spices are brought by caravans from distant countries, and that those who brought them, on being asked where the said spices grow, answered that they do not know, but that other caravans come to their homes with this merchandise from distant countries, and these again say that they are brought to them from other remote regions. And he argues thus: That if the Orientals affirmed to the Southerners that these things come from a distance from them, and so from hand to hand, presupposing the rotundity of the earth, it must be that the last ones get them at the north toward the west; and he said it in such a way that, having nothing to gain or lose by it, I too believe it. And what is more, the king here, who is wise and not lavish, likewise puts some faith in him, for since his return he has made good provision for him, as the same Master John tells me. And it is said that in the spring his majesty aforenamed will fit out some ships and will besides give him all the convicts, and they will go to that country and make a colony, by means of which they hope to establish in London a greater storehouse of spices than there is in Alexandria. And the chief men of the enterprise are of Bristol, great sailors, who, now that they know where to go, say that it is not a voyage of more than fifteen days, nor do they ever have storms after they get away from Hibernia. I have also talked with a Burgundian, a comrade of Master John's, who confirms everything and wishes to return thither, because the admiral (for so Master John already entitles himself) has given him an island, and he has given another one to a barber of his from Castiglione, of Genoa, and both of them regard themselves as counts, nor does my lord admiral esteem himself anything less than a prince. I think that with this expedition there will go several poor Italian monks who have all been promised bishoprics, and as I have become a friend of the admiral, if I wish to go thither I should get an archbishopric. But I have thought that the benefices which your excellency has in store for me are a surer thing, and, therefore, I beg that if these should fall vacant in my absence you will cause possession to be given to me, taking measures to do this rather where it is needed, in order that they may be not taken from me by others, who, because they are present, can be more diligent than I, who in this country have been brought to the pass of eating ten or twelve dishes at every meal and sitting at table three hours at a time twice a day for the sake of your excellency, to whom I humbly commend myself.

"Your excellency's very humble servant,

(Signed) "RAIMUNDUS."

"London, December 18, 1497."

The Abbé Raimondo de Soncino (the writer of the above) has made an earlier reference to this matter in a letter § which he wrote on August 24 of the same year to his government. He says:

"Also, some months ago, his Majesty sent out a Venetian, who is a very good mariner and has good skill in discovering new islands, and he has returned safe, and has found two very large fertile new islands, having likewise discovered the seven cities, 400 leagues from England, in the west passage. This next spring his Majesty means to send him with fifteen or twenty ships."

Purchas (His Pilgrimes), writing in 1625, gives another account of this voyage, but it is not to be preferred to that of the Abbé Raimondo, because Raimondo writes before the inception of the second voyage, and also is a contemporary of Cabot, and has had the account direct from him and his companions, whereas Purchas writes from second hand information and more than a century after the time, and may have confused some of the incidents of the first with those of the second voyage. Purchas says:

"In the year 1496, there was a Venetian in England called John Cabota, who having knowledge of such a new discovery as this was (referring to the discovery by Columbus of Hispaniola or of Jamaica), and perceiving by the globe that the islands before spoken of stood almost in the same latitude with his country, and much nearer to England than to Portugal or to Castile, he acquainted Henry VII, then King of England, with the same, wherewith the King was greatly pleased, and furnished him out with two ships and three hundred men, which departed and set sail in the spring of the year, and they sailed westward till they came in sight of land in 45 degrees of latitude, toward the north, and then went straight northward till they came into 60 degrees of latitude, where the day is eighteen hours long, and the night is very clear and bright. There they found the air cold, and great islands of ice, but no ground in 100 fathoms sounding; and so from thence finding the land (now called New Scotland) to turn eastward, they trended along by it, discovering all the Bay and River named Descada to see if it passed on the other side. Then they sailed back again till they came to 38 degrees toward the Equinoctial line, and from thence returned into England. There be others which say that he went as far as the Cape of Florida, which standeth in 25 degrees."

Barrett (Antiquities of Bristol, p. 172) has the following entry: "Newfoundland was found by Bristol men, June 24, 1497 (St. John's Day), in a ship called the Matthew," and this is undoubtedly correct.

Robert Fabian (who died in 1511) says that John Cabot discovered the American continent on June 24, 1497.

Thus we see that Cabot was supported not only by royal authority, but by the pecuniary resources of Bristol merchants; that he sailed in the early part of May, 1497, with three or four small ships, one of which—probably the one in which he embarked himself—was called the Matthew; that after leaving Ireland he sailed westward, and after passing over some 700 leagues discovered land on June 24 of the same year; that he planted the English banner there, and took possession of it in the name of King Henry VII of England.

What was this land? The quantity of fish, doubtless codfish, points conclusively to the truth of what Barrett asserts, that he was in the close neighborhood of Newfoundland; he probably first touched the island of Cape Breton. If he coasted three hundred miles, he would have made a voyage of the Gulf of St. Lawrence, returning home through the Straits of Belle Isle, in which event he would have hugged a very large portion of the coast of Newfoundland. The passage between the southeast point of Newfoundland and of Cape Breton Isle is still called Cabot Straits. On his return he saw two islands on the starboard, but provisions running short he did not stop to examine them. He does not appear to have seen any human beings, but he brought home some fishing tackle and tokens that the land was inhabited.

As we see from the letters of Raimondo, the Bristol merchants were fully persuaded of the possibility of colonizing the new land, and even proposed to establish a fishery on a large scale for the purpose of stock fish.

His son, Sebastian Cabot, was also a navigator,* and it has been suggested that he endeavored to stifle the work done by his father, in order to increase his own glory, and to cause the discoveries made by his father to be attributed to him. Be this as it may, we are able to glean some information concerning John Cabot, even from the son. Sebastian had a map dated 1544 (but whether made really by him, or at an earlier date by his father, is unknown). On this map a legend appears against certain land, which seems to indicate the isle of Cape Breton, and especially that part of it called Cape Pereé as being the Prima tierra vista of John Cabot; and the island which John Cabot calls St. John's Isle is probably Prince Edward Island. This legend is written in Spanish, and there is a Latin translation of it, which reads as follows:

"No. 8——John Cabot, a Venetian, also Sebastian Cabot, his son, opened this land, formerly closed to us, in the year from the redemption of the world 1494,† on the 24th day of July,‡ at five o'clock in the morning, which they called the land first seen, and a certain great island opposite to it, which they called the isle of St. John, because it was opened to them on the feast of St. John. The inhabitants of this land § are clothed in the skins of animals, and use the bow in war, arrows, darts, spears, wooden clubs, and slings. The land was sterile and uncultured, and abounding with lions,‖ white bears, and very large stags, innumerable fish—viz., seals, salmon, and great soles of one yard in length, and other different kinds of fish; there is great abundance of them, and the common people call them bacallios; ¶ to them also are dark hawks like crows, eagles, partridges of dark color, and other different birds."

Hakluyt has a similar account of this legend (Voyages, folio edition of 1589), heading it:

"An extract taken out of the map of Sebastian Cabot (cut by Clement Adams) concerning his discoveries of the West Indies, which is to be seen in Her Majesty's Privy Gallery at Westminster, and in many other ancient merchants' houses."

To return to John Cabot. He proposed to return to his new found land, as has been before suggested. On this occasion he obtained new letters patent from King Henry VII, dated the 3d of February, 1498. They recite as follows:

"To all men to whom these presents shall come sending greeting. Know ye that we of our grace especial and for divers causes us moving have given and granted and by these presents give and grant to our well beloved John Kabotto (Cabot), Venetian, sufficient authority and power that he, by him, his deputy or deputies sufficient, may take at his pleasure six English ships in any port or ports or other place within our Realm of England, or obeisance thereto, and if the said ships be of the burthen of 200 tons or under, with their apparel, requisite and necessary for the safe conducts of the said ships, and them convey and lead to the Land and Isles of late found by the said John, in our name and by our commandment, paying for them and every of them, as and if we should in and for our own case pay, and not otherwise."

The letters then proceed to grant permission to the said John Cabot to take with him "such master mariners, pages, and our subjects" as are willing to go to the said land and isles; lastly, these letters command all officers, as well by land as by sea, to be succoring the said John Cabot. It is to be observed that these letters make no mention of his sons, but as a fact he took Sebastian with him. John Cabot was now a rising man. On August 10, 1497, the king had presented him with ten pounds, a substantial sum in those days, in testimony of his discovery. We find this from the Privy purse account of the king: "10th August, 1497. To him that found the new Isle £10." Further, the king granted him an annuity of twenty pounds sterling charged on the customs of Bristol. The order is as follows:

"We let you wit that we for certain considerations Us specially moving, have given and granted unto Our well beloved John Cabot of the port of Venice an annuity or annual rent of Twenty pounds sterling, to be had and paid yearly from the Feast of the Annunciation of Our Lady last past, during Our pleasure, of our Customs and subsidies coming and growing in Our Port of Bristowe, by the hands of Our Customs there for the time being at Michaelmas and Easter by even portion. Wherefore we will and charge you that under Our Great Seal ye do make hereupon Our Letters Patent in good and effectual form. Given under Our Privy Seal at Our Palace of Westminster the Thirteenth day of December, the Thirteenth Year of Our Reign (1497)."

This order is directed by the king to the chancellor, and passed the chancery on the 28th of January, 1498.

John Cabot set sail on his second voyage in the early part of 1498 (probably in the month of June) from Bristol. Very little is known of his second voyage, and, apparently, he never returned. He took Sebastian with him, and it is from the jealous Sebastian that we obtain some few tidings of John Cabot's second voyage. He sailed with three hundred men; one ship put back to Ireland in distress. Cabot steered northwest and came to a coast (probably Labrador) running to the north, which he followed to a great distance. There he found, although it was the month of July, that large bodies of ice were floating on the sea, and that it was almost continual daylight. Having failed to find a passage round this formidable headland, he sought rest and refreshment on the coast of Newfoundland (which Sebastian calls Bacallios, i. e., codfish). Thence he coasted southward, and came about the latitude of Gibraltar, or 36° north, searching for a passage to India. But, the provisions failing, the ships returned to England, whether with or without the illustrious explorer, John Cabot, is unknown. It is clear that his son Sebastian returned to Bristol, and he and his companions (for he suppresses his father's name) had landed in several places, and saw the natives and various animals. The expedition was expected to return to Bristol in September, 1498, but it evidently returned much later.

We glean something of this second voyage from a garbled statement of Sebastian, which is taken* from the sixth chapter of the Third Decade of Peter Martyr of Angleria. Martyr says:

"These North Seas have been searched by one Sebastian Cabot, a Venetian born, whom being yet but in manner an infant, his parents carried with them into England, having occasion to resort thither for trade of merchandise, as is the manner of the Venetians to leave no part of the world unsearched to obtain riches. He, therefore, furnished two ships in England at his own charges, and first with three hundred men directed his course so far toward the north pole, that even in the month of July he found monstrous heaps of ice swimming on the sea, and in manner continual daylight, yet saw he the land in that tract free from ice, which had been melted by the heat of the sun. Thus, seeing such heaps of ice before him, he was forced to turn his sails and follow the west, so, coasting still by the shore, that he was thereby brought so far into the south, by reason of the land bending so much southward, that it was there almost equal in latitude with the sea Fretum Herculeum. Having the north pole situate in manner in the same degree, he sailed likewise in this tract so far toward the west, and he had the island of Cuba on his left hand, in manner in the same degree of longitude. As he traveled by the coasts of this great land (which he named Baccalaos), he said that he found the like course of the waters toward the west, but the same to run more softly and gently than the swift waters which the Spaniards found in their navigations southward. Wherefore it is not only more like to be true, but ought also of necessity to be concluded, that between both the lands hitherto unknown there should be certain great open places whereby the waters should thus continually pass from the east unto the west, which waters I suppose to be driven about the globe of the earth by the incessant moving and impulsion of the heavens, and not to be swallowed up and cast up again by the breathing of Demogorgon, as some hath imagined, because they see the seas by increase and decrease to ebb and flow. Sebastian Cabot himself named those lands Baccalaos, because that in the seas thereabout he found so great multitudes of certain big fishes much like unto tunies (which the inhabitants call Baccalaos) that they sometimes stayed his ships. He found also the people of those regions covered with beasts' skins, yet not without the use of

* Letter found in the state archives of Milan, first published in 1865, in the Annuario Scientifico. Translated by Prof. Bennet H. Nash, of Harvard College.

† I am unable to discover what land is here intended.

‡ Probably Japan.

§ Venetian Calendar, A. D. 1202 to 1509, i, 260.

* See an article, by the late Sir Travers Twiss, in the Nautical Magazine for July and August, 1876.

† This date is wrong, and should be 1497. It is not clear what the object of Sebastian was in giving a false date, unless it be to place a greater distance between his father and him, and to make it appear that he himself was the navigator who commanded in the voyage of 1497.

‡ This should be June; it is so in the Spanish.

§ Sebastian is here speaking from his own knowledge, for it will be remembered that his father found no inhabitants, only traces of some.

‖ Lions not in the Spanish.

¶ He means the common people of Spain, not the savages of the island, as erroneously translated by Hakluyt (Voyages, folio edition of 1589). The world bacallios is the Basque for cod.

* Hakluyt (Voyages, folio edition of 1589) has copied this, from whence we have extracted it.

reason. He also said there is great plenty of bears in those regions which used to eat fish; for plunging themselves into the water where they perceive a multitude of these fishes to lie, they fasten their claws in their scales, and so draw them to land and eat them, so (as he saith) the bears, being thus satisfied with fish, are not noisome to men. He declares, further, that in many places of these regions he saw great plenty of copper among the inhabitants. Cabot is my very friend whom I know familiarly, and delight to have him sometimes keep me company in my own house. For, being called out of England by the commandment of the Catholic King of Castile, after the death of King Henry the VII of that name, King of England, he was made one of our counsel and assistants as touching the affairs of the new Indies, looking for ships daily to be furnished for him to discover this hid secret of nature."

It is further supposed that the discoveries of John Cabot have been preserved on the map of Juan de la Cosa, a Spaniard, who, in 1500, was supplied by the Spanish embassy in London with a copy of John Cabot's map (now lost). Cosa indicates by English flags the discoveries of Cabot along the North American coast, which appear to range from 50° to 30°—south of Cape Breton to a little south of Cape Hatteras.

In 1583, Sir Humphrey Gilbert, Kt., again took formal possession of Newfoundland in the name and to the use of Queen Elizabeth; for a perpetual witness whereof, he erected on the shore a pillar, whereon the royal arms of England were supported. Several plantations were made from England by virtue of royal letters patent; among others the London plantation in 1611, the Bristol plantation in 1618, and the plantation of Sir George Calvert, Kt., in 1621.

On the 24th of this month four hundred years will have run* since the day on which John Cabot found the new world, and it is desirable that this important event should not be allowed to remain in the quasi obscurity with which it has been surrounded for so long. We trust that these few pages will prove interesting to our countrymen, and in some small degree help to revive the fame of John Cabot and the glory of the English monarch who sent him.

SHERSTON BAKER.

* June 24, 1497, of course, was the old style, but it is sufficiently close.

The completion of the Chicago drainage canal requires the expenditure of $3,685,648 more than the $28,258,748 now provided for, according to a majority report of the finance committee of the board of trustees recently made public, says Engineering News. This additional amount brings the cost of the canal completed ready for use up to $31,444,397. A minority report of the same committee places the required sum to finish the work at $1,396,191, and with the present state of factional ill feeling in the board of trustees considerable acrimonious discussion has resulted. The majority faction has, however, accepted the minority committee report, and a bill is now being prepared to be submitted to the State Legislature of Illinois, which amends the act of 1895 so that the present tax levy of 1½ per cent. for the construction work of the canal shall continue until 1899, instead of terminating now. The passage of this amendment will, it is believed, be sufficient to provide the $3,685,000 needed to complete the work. It is also the intention of the board of trustees to present to the legislature two other bills, one giving to the board the right to use any part of the waterway of the Illinois and Michigan Canal controlled by the State, provided said waterway is left in the condition it is found in; the other, giving to the board the right to condemn water power now existing, but which later may conflict with the needs of the sanitary district.

Remedy for Caterpillars.—A simple remedy against caterpillars consists of sprinkling with lime the plants affected. The lime is harmless to the plants, but deadly to the caterpillars. Moreover, it is washed into the ground by the rain and dew, and constitutes a good fertilizer.—Wiener Gewerbe Zeitung.

OUR GREAT POPULAR OFFER!

A Complete Electrical Library

BY PROF. T. O'CONOR SLOANE.

5 Volumes for $5.00.

A VALUABLE AND INDISPENSABLE ADDITION TO ANY LIBRARY.

THOUSANDS of ambitious men, young and old, who are thirsting for a practical knowledge of the science of Electricity, and desire to become electrical engineers, are prevented by circumstances from attending the higher institutions of learning. These will hail with delight our liberal offer and the exceptional opportunity of obtaining

An Electrical Education at a Nominal Cost

by securing the five following books by Prof. T. O'CONOR SLOANE, comprising a COMPLETE ELECTRICAL LIBRARY, in which the various branches of electrical work may be thoroughly studied. The following is a synopsis of some of the contents of the five volumes:

Electricity Simplified. This work is the simplest ever published on the subject. Electricity is in many respects unexplained by the scientist; to the ordinary man it is all a mystery. This book makes the subject as plain as possible. Shows how two plates of different metals immersed in acid can send a message around the globe; how a bundle of copper wire rotated by a steam engine can be the agent in lighting our homes and streets, etc. By illustrations of original design and scope, the subject is made exceedingly simple. 158 pages, illustrated. Price $1.00.

Arithmetic of Electricity. A practical treatise on electrical calculations of all kinds reduced to simple rules and illustrated by practical problems with solutions, followed by an exhaustive series of tables. One of the most useful works published on electricity. 138 pages, illustrated. Price $1.00.

Electric Toy Making, Dynamo Building and Electric Motor Construction. A work for amateurs and young folks. Shows how to make at home Electrical Toys, Motors, Bells, Magnets, Batteries, Dynamos, and electrical instruments in general. 140 pages, illustrated. Price $1.00.

How to Become a Successful Electrician. Indicates how the student may become a self-taught electrical engineer without the great expenditure of time and money incident to a college course. 189 pages, illustrated. Price $1.00.

THE STANDARD ELECTRICAL DICTIONARY. An indispensable work to all interested in electrical science. Suitable alike for the student and professional. A practical handbook of reference containing definitions of about 5,000 distinct words, terms and phrases. Definitions are terse and concise and include every term used in electrical science. **An entirely new edition brought up to date and greatly enlarged.** Should be in the possession of all who desire to keep abreast with the progress of this branch of science. Complete, concise and convenient. 682 pages, 393 illustrations. Price $3.00.

☞ **These valuable books can be had separately at the published prices.**

SPECIAL OFFER to readers of the SCIENTIFIC AMERICAN and their friends. We are able to furnish the above five volumes, handsomely bound, and inclosed in a neat folding box as shown in the illustration, at the **Special Reduced Price of Five Dollars for the Complete Set.** *You save $2.00 by ordering the complete set.* Sent by mail or express, prepaid, to any address in North America. To foreign countries, by mail, post-free, in separate parcels, at the same price.

A $7.00 ELECTRICAL LIBRARY FOR $5.00.

5 VOLUMES.——1300 PAGES.——OVER 450 ILLUSTRATIONS.

☞ Send for special circular of the complete contents of all of these books. Also for our complete 116 page book catalogue sent free to any address.

MUNN & CO., Publishers, 361 Broadway, New York.

THE

Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50 stitched in paper, or $3.50 bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents, and canvassers.

MUNN & CO., Publishers,
361 Broadway, New York, N. Y.

TABLE OF CONTENTS.

Now Ready.

MAGIC

Stage Illusions and Scientific Diversions Including Trick Photography.

COMPILED AND EDITED BY ALBERT A. HOPKINS.

WITH AN INTRODUCTION BY HENRY RIDGELY EVANS.

568 Pages, 420 Illustrations. **Price, by mail, $2.50.**

THIS new work on Magic, Stage Illusions and Trick Photography appeals to the professional and the amateur alike, and will prove a welcome addition to any library, and will be read with interest by young and old. The illusions are well illustrated by engravings, which fully explain the nature of the tricks. Great attention is paid to the exposés of large and important illusions. Some of the most important tricks of Robert Houdin, Bautier de Kolta, Kellar and Herrmann are explained. Conjuring tricks are not neglected, and Fire Eaters, Sword Swallowers, Ventriloquists, etc., all come in for a share of attention. The section devoted to "Photographic Diversions" is very complete, illustrating the most important forms of trick photographs which the amateur can make. There is also a valuable Bibliography of Books on Natural Magic. The book is a large octavo and is handsomely bound.

☞ An illustrated circular giving specimens of the engravings, together with a full table of contents, will be mailed free to any address.

MUNN & CO., PUBLISHERS,
361 BROADWAY NEW YORK CITY.

PATENTS!

MESSRS. MUNN & CO., in connection with the publication of the SCIENTIFIC AMERICAN, continue to examine improvements, and to act as Solicitors of Patents for Inventors.

In this line of business they have had *fifty years' experience*, and now have *unequaled facilities* for the preparation of Patent Drawings, Specifications, and the prosecution of Applications for Patents in the United States, Canada, and Foreign Countries. Messrs. Munn & Co. also attend to the preparation of Caveats, Copyrights for Books, Trademarks, Reissues, Assignments and Reports on Infringements of Patents. All business intrusted to them is done with special care and promptness, on very reasonable terms.

A pamphlet sent free of charge, on application, containing full information about Patents and how to procure them: directions concerning Trademarks, Copyrights, Designs, Patents, Appeals, Reissues, Infringements, Assignments, Rejected Cases. Hints on the Sale of Patents, etc.

We also send, *free of charge*, a Synopsis of Foreign Patent Laws, showing the cost and method of securing patents in all the principal countries of the world.

MUNN & CO., Solicitors of Patents,
361 Broadway, New York.

BRANCH OFFICES.—No. 622 and 624 F Street, Pacific Building, near 7th Street, Washington, D. C.